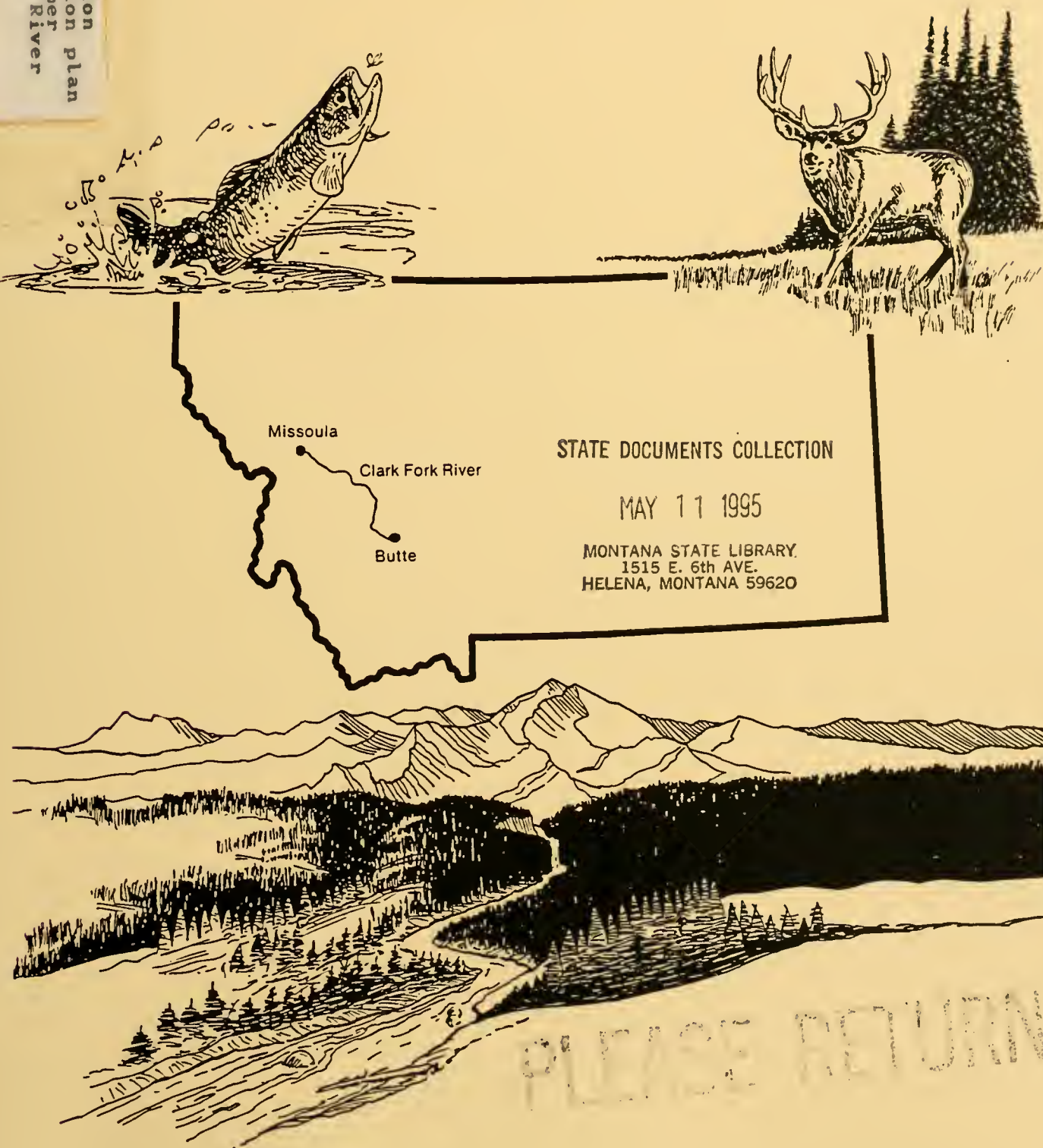


STATE OF MONTANA
NATURAL RESOURCE DAMAGE PROGRAM

RESTORATION DETERMINATION PLAN
UPPER CLARK FORK RIVER BASIN

JANUARY 1995

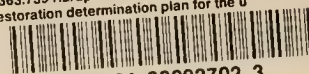


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RESTORATION DETERMINATION PLAN FOR THE UPPER CLARK FORK RIVER BASIN

STATE OF MONTANA

**Natural Resource Damage Litigation Program
Old Livestock Building
1310 East Lockey Avenue
Helena, Montana 59620**

ROCKY MOUNTAIN CONSULTANTS, INC.

**Premiere Building
700 Florida Avenue, Suite 500
Longmont, Colorado 80501**

January 1995



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RESTORATION DETERMINATION PLAN
UPPER CLARK FORK RIVER BASIN

Don W. Deere (CEM)
Donald W. Deere
Rocky Mountain Consultants, Inc.
700 Florida Avenue, 5th Floor
Longmont, CO 80501

Tom Hesemann (CEM)
Thomas J. Hesemann
Rocky Mountain Consultants, Inc.
700 Florida Avenue, 5th Floor
Longmont, CO 80501

Mark Kerr
Mark Kerr
Natural Resource Damage
Litigation Program
P.O. Box 201425
Helena, MT 59620-1425

Ann Maest (CEM)
Dr. Ann Maest
RCG/Hagler, Bailly, Inc.
P.O. Drawer 0
Boulder, CO 80306-1906

Dale E. Miller (CEM)
Dale E. Miller
Inter-Fluve, Inc.
25 N. Willson Ave, Suite 5
Bozeman, MT 59715

William Platts (CEM)
William Platts
Chapman & Associates
3653 Rickenbacker Rd, Suite 200
Boise, ID 83705

Hector Galbraith (CEM)
Hector Galbraith
RCG/Hagler, Bailly, Inc.
P.O. Drawer 0
Boulder, CO 80306-1906

Lawrence A. Kapustka (CEM)
Dr. Lawrence A. Kapustka
ecological planning & toxicology
5010 S.W. Hout
Corvallis, OR 97333-9540

Josh Lipton (CEM)
Dr. Joshua Lipton
RCG/Hagler, Bailly, Inc.
P.O. Drawer 0
Boulder, CO 80306-1906

John J. Metesh (CEM)
John J. Metesh
MT College of Mineral Sciences
1300 West Park
Butte, MT 59701

Gregory J. Mullen
Gregory J. Mullen
Natural Resource Damage
Litigation Program
P.O. Box 201425
Helena, MT 59620-1425

William Woessner (CEM)
Dr. William Woessner
University of Montana
126 McLeod Avenue
Missoula, MT 59801

January 1995



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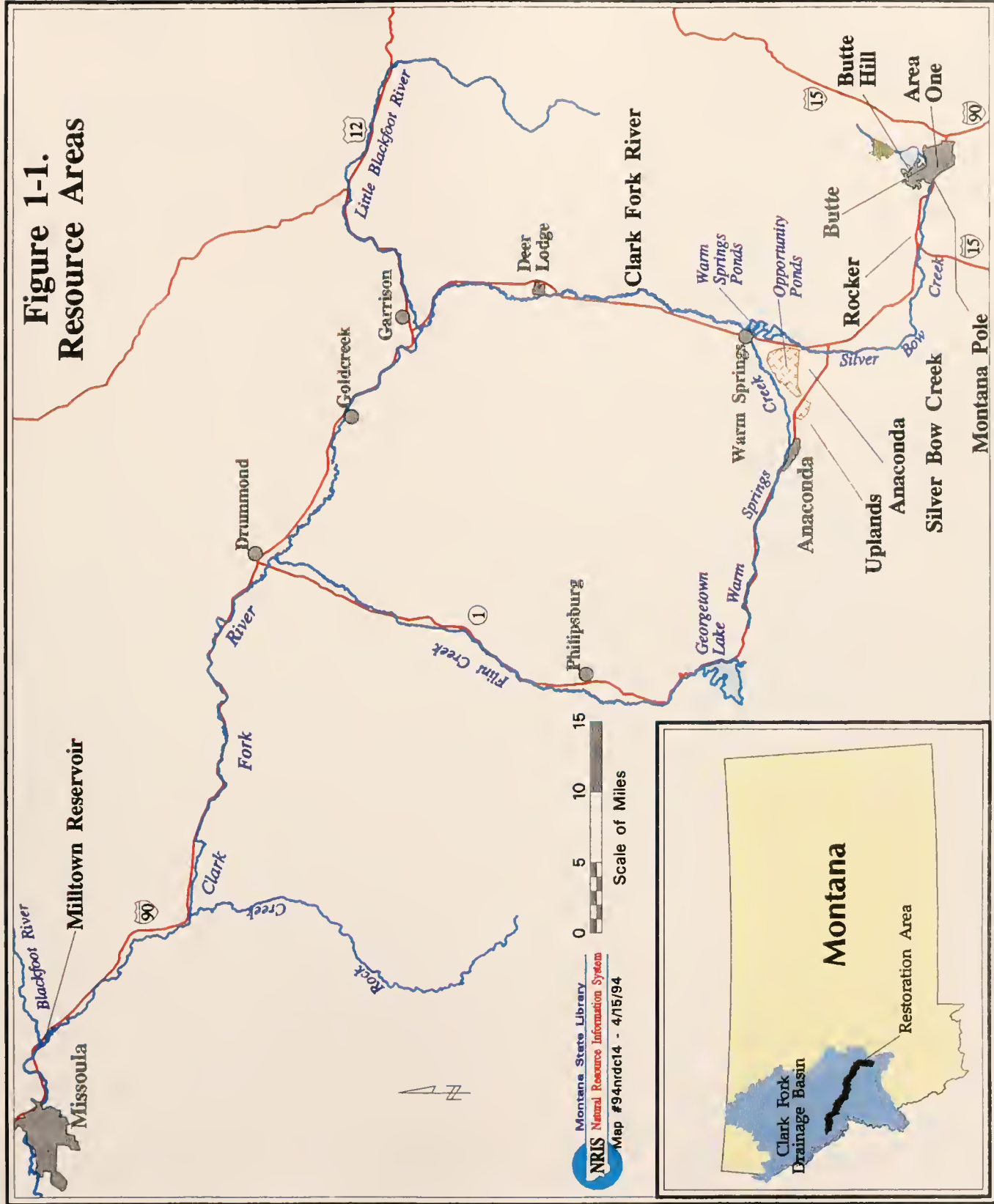
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**Figure 1-1.
Resource Areas**



UPPER CLARK FORK RIVER BASIN RESTORATION DETERMINATION PLAN

1.0 INTRODUCTION

1.1 Request For Public Comment

This plan arrays and selects alternatives for the restoration of natural resources in the Upper Clark Fork River Basin. Preparation of the plan is pursuant to and in accordance with: 1) the natural resources damage provisions of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, (CERCLA), 42 U.S.C. §9601 et seq. (otherwise known as Superfund); 2) the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), Mont. Code. Ann. §75-10-701--724 (1993); and 3) the Natural Resource Damage Assessment regulations of the Department of the Interior (DOI), which implement CERCLA's natural resource damage provisions. 43 C.F.R. §11.

Section 11.81 of the DOI regulations requires the preparation of a Restoration and Compensation Determination Plan (RCDP). Under the regulations, the RCDP is comprised of two basic components. First, the RCDP is to array restoration alternatives and then select from among the alternatives. Second, the RCDP is to outline various methodologies for estimating the costs of the alternatives and for estimating compensable values. The instant Restoration Determination Plan (RDP) undertakes the former task but not the later. Cost estimating and valuation methodologies were previously outlined by the State in the Assessment Plan, Part II, released on April 24, 1992 for public comment. These comments have been considered by the State of Montana; responses are contained in the Response to Comments volume of the Report of Assessment.

Although not required by the regulations, the State of Montana released, on March 22, 1994, a Restoration Report and invited comments in order to maximize opportunities for public input. That report was the State's initial effort to develop alternatives for restoration of resources in the Upper Clark Fork River Basin. A few comments were received. These comments have been considered; however, responses to the comments are not currently provided. Rather, responses to these comments will be contained in a subsequently released

Response to Comments document.

The Response to Comments document will also contain responses to comments received on the RDP. The State's consideration of comments may necessitate changes to the RDP. A final RDP subsequently will be issued along with responses to comments.

Comments on the RDP must be received on or before February 21, 1995 to ensure their consideration. Mail or deliver comments to:

Natural Resource Damage Litigation Program
State of Montana/Department of Justice
P.O. Box 201425
Old Livestock Building
1310 East Lockey Avenue
Helena, MT 59620-1425

1.2 Legal Overview

1.2.1 Background

Past mining and mineral processing activities and wood treating operations of the Atlantic Richfield Company and its predecessors have resulted in widespread injury to natural resources in the Upper Clark Fork River Basin. The U.S. Environmental Protection Agency (EPA) has divided the impacted area into four sites and has placed the sites on the National Priorities List (NPL), which is a list of contaminated sites across the nation most in need of immediate clean-up to "protect the public health or welfare or the environment." 42 U.S.C. §9604(a)(1). These sites are: the Silver Bow Creek/Butte Addition site, the Montana Pole site, the Anaconda Smelter site, and the Milltown Reservoir/Clark Fork River site. Together these sites comprise the largest collection of Superfund sites in the country.

CERCLA and CECRA allow states as trustees for natural resources to recover monetary damages for injuries to natural resources caused by releases of hazardous and deleterious substances. In 1983, the State of Montana, pursuant to its role as trustee, filed suit against the Atlantic Richfield Company to recover damages for injuries to the natural resources of the Upper Clark Fork River Basin. In the course of this litigation, the State of Montana undertook, through its Natural Resource Damage Litigation Program, the preparation of a natural resource damage assessment to document the injury and determine the amount of damages.

Assessment activities up to the present include the preparation and release of a preassessment screen, and a three-part assessment plan that included an opportunity for public comment. In addition, three injury assessment reports have been issued. These reports were first released in 1993, and have been revised and are being rereleased at this time. The injury assessment reports (incorporated herein by reference)--on aquatic resources; terrestrial resources, including riparian and upland soils, vegetation, wildlife, and wildlife habitat resources; and groundwater resources--demonstrate that mining and mineral processing activities and wood treating operations in the Upper Clark Fork Basin have released "hazardous" and "deleterious" substances as those terms are defined in CERCLA and CECRA; and that these releases have resulted, and continue to result, in severe and widespread injuries to natural resources.

After injuries are determined to exist and are quantified, the natural resource damage assessment regulations require a damage determination in order to "establish the amount of money to be sought in compensation for injury to natural resources resulting from a ... release of a hazardous substance." 43 C.F.R. §11.80(b). There are two parts to a natural resource damage award. First, a trustee can recover compensable value, which DOI identifies as "the value of lost public uses of the services provided by the injured resource, plus lost nonuse values such as option, existence, and bequest values." 43 C.F.R. §11.83(c)(1). Compensable value has been addressed in three reports--also previously issued, revised, and rereleased at this time--"Assessment of Damages to Anglers and Other Recreators," "Contingent Valuation of Natural Resource Damage," and "Compensable Natural Resource Damage Determination."

Second, and in addition to compensable value damages, a trustee can also recover damages based on the cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured resources (hereinafter collectively termed restoration). This plan is concerned with this measure of damages.

1.2.2 Restoration Generally and the Concept of Baseline

CERCLA makes clear that the purpose of the natural resource damage provisions is to restore injured resources. For example, the statute requires that monies recovered by a trustee be used "only to restore, replace, or acquire the equivalent of such natural

resources." 42 U.S.C. §9607(f)(1). Relying on this language, the United States Court of Appeals for the District of Columbia Circuit held that restoration costs are the principal measure of damages in a natural resource damage case. State of Ohio v. DOI, 880 F.2d 432 (D.C. Cir. 1989). According to the Court, in fashioning the natural resource damage provisions Congress intended "to effect a 'make whole' remedy of complete restoration." 880 F.2d at 445.

In order to implement the statutory preference for restoration, the DOI regulations employ the term "baseline," which is defined simply as the condition of the resource had the release of hazardous substances not occurred. 43 C.F.R. §11.14(e). This definition ensures that liability will only attach to injuries attributable to the release in question. The goal of restoration is to return the injured resource to baseline conditions. 58 Fed. Reg. 39341 (col. 2), 59 Fed. Reg. 14272 (col. 3). Thus, restoration does not aim to produce a pristine resource. No restoration alternative considered by the State goes beyond baseline.

More specifically, the objective of restoration is to "return to baseline levels both the injured natural resources and the services that the natural resources provide to the public." 56 Fed. Reg. 19757 (col. 1). In broad terms, a service is any function or utility that one resource provides for another resource or for human beings. Thus, services include "ecological services as flood and erosion control, habitat, and food chains, as well as such human uses as recreation." 51 Fed. Reg. 27679 (col. 3). The ability of a resource "to absorb low levels of [contamination] without exceeding standards or without other effects" is also a service. 51 Fed. Reg. 27716 (col. 2), see also 59 Fed. Reg. 14273 (col. 1).

Restoration of services is accomplished by restoring resources. DOI has stated, "although it is the natural resource that trustees are restoring, restoration of that resource causes an increase in services. . . ." 58 Fed. Reg. 39340 (col. 1). When services are restored to baseline levels, restoration is deemed complete. Id. Accordingly, this report necessarily focusses on restoring injured resources to baseline conditions. For each alternative, estimates will be provided of when resources, and hence services, will return to baseline levels. Given the severity of the injury to the Basin and the time frames involved, estimates of this nature cannot purport to be exact. The estimates, however, reflect the State of Montana's considered judgment informed by knowledge of the resources and the injuries

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and after consultation with experts in the field.

It must be observed that the State of Montana harbors no illusions about what can practically be accomplished in the Upper Clark Fork River Basin given the type and pervasiveness of contamination and the magnitude of the injuries to the State's natural resources. Restoration will be difficult if for no other reason than the fact that metals and metalloids like arsenic, which are responsible for much of the contamination in the Upper Clark Fork River Basin, do not degrade, rather they must be removed, otherwise isolated, or leave the system naturally for injuries to be mitigated. Although it may be possible in some instances of natural resource injury for human intervention to restore resources and services to baseline levels in years or even decades, for the most part this is not such a case. Generally, the most that can be achieved in the way of restoration of the Upper Clark Fork River Basin within the lifetimes of persons alive today is to ameliorate natural resource injuries, enabling the resource and the services provided by the resources to recover substantially.

For each alternative, the report estimates the time frame for substantial recovery. Substantial recovery, as that term is employed here, embodies the State of Montana's estimation of the length of time for the productivity of the resource, or its ability to provide services, to be greatly enhanced relative to existing conditions. Like estimates of restoration to baseline, estimates of substantial recovery involve uncertainty, depending on difficult projections of effects resulting from various actions.

By making a distinction between restoration to baseline and substantial recovery, the report acknowledges the severity of injury in the Upper Clark Fork River Basin and emphasizes that the extent of injury and inability of human beings to fully redress the injury do not, by themselves, justify taking no action. Indeed, actions that improve the condition of the resource and lead to substantial recovery, even if not producing short-term restoration to baseline, will accelerate restoration.

1.2.3 Response Actions and the Relationship Between Restoration and Response

While the concept of baseline indicates where restoration stops, it does not aid in determining where restoration actions are to begin. At the Clark Fork River NPL sites various response actions have occurred and will continue to occur. Such actions, directed

and ordered by EPA and the Montana Department of Health and Environmental Sciences (MDHES), are not typically undertaken to restore resources, but rather to address any actual or potential threat to public health or the environment. Nonetheless, these response actions tend to mitigate injuries to natural resources. This movement towards a resource's baseline condition must be taken into account during restoration planning. A trustee cannot seek damages to restore what has already been accomplished by response actions. Put another way, natural resource damage restoration can only address those injuries that are residual to, or left over after, response actions.

In order to ensure that the "effects of response actions shall be factored into the analysis of damages," the regulations require that "[i]f response actions will not be completed until after the assessment has been initiated, the anticipated effects of such actions should be included in the assessment." 43 C.F.R. §11.84(c)(2). For this plan, it is necessary to anticipate the effects of two kinds of response actions: those that have been selected and those that have not yet been selected. In the former case, effects are anticipated by analyzing the various decisionmaking documents, such as the Record of Decision, to identify what the response action would achieve and what it would not achieve insofar as injury mitigation is concerned.

In cases where the response action has not yet been selected--and several have not--it is necessary as a threshold matter to make a best estimate of what the response action will be. The effects of the estimated action are then projected. This is done by reviewing pertinent documents, such as Remedial Investigation and Feasibility Studies (RI/FS), which describe the site and detail the response action alternatives, by evaluating the effects or anticipated effects of planned or potential actions at various sites in the Basin, by considering the Atlantic Richfield Company's projection of remedy, and by discussing the subject with EPA and MDHES personnel.

At sites where the RI/FS process is ongoing, neither EPA nor MDHES would, or could, state whether any potential response action would or would not be selected. Nothing contained herein should be construed as indicating an opinion by EPA or MDHES on the merits of potential response actions.

A further point on the relationship between response actions and restoration planning

bears noting. The differing statutory and regulatory schemes under which CERCLA response authorities and natural resource trustees operate create the potential for inconsistent response actions and restoration actions. While a response action at a particular site may meet its goals to protect public health and the environment, a restoration action at the same site may require a different approach than that taken by the response action to meet its goals. Based on this reasoning, DOI has made it plain that trustees are not barred from selecting a restoration action that is inconsistent with a chosen or anticipated response action. 58 Fed. Reg. 39344 (col. 1), 39346 (col. 2), 59 Fed. Reg. 14274 (col. 2).

To produce maximum gains to the resource, it would be preferable to mesh response and restoration actions. This can be achieved only by coordination among the various governmental entities involved--EPA, MDHES, and the Natural Resource Damage Litigation Program.

As a matter of policy, coordinating cleanup actions in the Upper Clark Fork River Basin--be they response or restoration actions--makes good sense. Accordingly, restoration alternatives presented in this report assume that such coordination will occur. Thus, if a restoration action were to take a different approach than a response action, since the restoration action would accomplish the goals of the response action and then some, the restoration action would be implemented and any conflict avoided.

This is not to say, however, that a restoration action would, by definition, be unacceptable if there was a conflict with a response action. If such an instance arose, despite efforts by response and restoration authorities to avoid such a conflict, the restoration alternative proposing the action would need to be evaluated like any other restoration alternative on a site-specific basis. Since this report is premised on the notion that coordination will occur, should this not happen this report will need to be revised to take into account the change in circumstances.

1.2.4 The Restoration Decisionmaking Process

The proposed regulations state that a trustee is to consider a reasonable number of methodologies or alternatives that will restore the injured resources. 43 C.F.R. §11.81(a). The trustee is advised to select a full spectrum of alternatives for restoring a resource. 56 Fed. Reg. 19757 (col. 1). This means that the trustee might consider an alternative that

returns the resource and its services to baseline conditions as soon as possible, as well as the alternative of no-action or letting the resource recover naturally. DOI emphasizes, however, that a trustee has broad discretion to decide, based on its expertise, what constitutes a full range of alternatives. 58 Fed. Reg. 39341 (col. 3). And, of course, as in any alternative analysis, only reasonable alternatives need be considered.

Alternatives may be constructed out of four kinds of trustee actions. These are restoration, rehabilitation, replacement, and acquisition of the equivalent. Given the broad range of types of actions allowed for, the plan does not attempt to pigeonhole alternatives into one or another of these actions.

Readers of this plan should be aware, however, that after considering its obligations as trustee, the State decided not to display alternatives that entailed land acquisition as a means of replacing lost services. The State arrived at this decision for two basic reasons. First, acquisition of land does nothing to improve the condition of the injured resources. Given the extent and severity of injuries and the relative abundance of land already in public ownership, the State deemed it preferable to select from among a range of alternatives that improved the condition of the injured resource. Second, it is the State's position that although, as described above, there may be circumstances where land acquisition is appropriate, CERCLA establishes a preference for trustee actions that specifically address the injured resources. Since, alternatives exist that actually improve the condition of injured resources, the State has chosen not to display in the RDP any land acquisition alternatives.

When selecting an alternative, a trustee must consider all relevant factors. There are ten factors that must be considered in all instances. 11 C.F.R. §11.82(d). No factor must be complied with, nor are some factors weighted more heavily than other factors. Rather, trustees are afforded a substantial degree of flexibility when selecting an appropriate restoration alternative. 56 Fed. Reg. 19757 (col. 3), 58 Fed. Reg. 39342 (col.2), 59 Fed. Reg. 14273 (col. 3). A discussion of the factors that must be considered follows.

1) Technical feasibility Under this factor, trustees must evaluate the degree to which the alternative utilizes "well known" technologies and how likely the alternative will "have a reasonable chance of successful completion in an acceptable period of time." 11 C.F.R. §11.14(qq). The focus of this factor is to evaluate varying levels of technical feasibility

between alternatives. 58 Fed. Reg. 39343 (col. 1).

2) Relationship of expected costs to expected benefits The purpose of this factor is to permit a comparison between alternatives with different costs and benefits, not to establish a cost-benefit ratio that is by definition unacceptable. 58 Fed. Reg. 39343 (cols. 1, 2). A trustee must weigh an alternative's costs against its benefits, both in terms of the recovery of the resource and the effects on the public. 56 Fed. Reg. 19758 (col. 1). Thus, the application of this factor is not a "straight cost/benefit analysis." Id. Rather, as noted, benefits are determined by evaluating not just the lost interim use (costs to the public until the resource returns to baseline) associated with the alternative, but also by evaluating the effect on the resource. While the former measure can be quantified, it is not possible to quantify the later measure. Indeed, this factor subsumes all the other factors and requires an evaluation of the costs (or disadvantages) of selecting an alternative with the benefits (or advantages) to be derived from that alternative's selection. All of the factors are designed to reveal an alternative's costs and benefits. Thus, since this factor relies on all the factors, it is the decisionmaking factor and will be discussed last when the factors are considered.

3) Cost-effectiveness This factor enables a trustee to compare alternatives that produce the same or a similar level of benefits. 43 C.F.R. §11.14(j). All of the other factors can be considered in determining the level of benefits produced by an alternative. 58 Fed. Reg. 39343 (col 3). For example, given two alternatives that will result in significantly different rates of recovery (see below for a discussion of this factor), cost-effectiveness cannot be used to compare the two.

4) Results of response actions This factor requires the trustee to consider the results of actual or planned response actions. Under this plan, as discussed above, the assumption is that coordination between response actions and restoration actions will occur. Thus, distinctions between alternatives based on their degree of consistency with response actions will not be possible. Also as noted, however, real-life inconsistency between a response action and a restoration action does not require rejection of the restoration action. But, it would require that this plan be revised since the operative assumption proved incorrect.

5) Potential for additional injury Under this factor, trustees must consider whether, and to what degree, an alternative will result in adverse environmental impacts.

6) Natural recovery In each of the injury reports, the State of Montana has estimated the time period for natural recovery assuming that only response actions are undertaken. Accordingly, this factor requires trustees to consider natural recovery when evaluating alternatives, but does not establish a rule or preference for when a trustee is to select natural recovery. 58 Fed. Reg. 39344 (col. 2). The appropriateness of natural recovery is to be determined by the trustee on a resource-by-resource basis.

7) Ability of the resource to recover This factor, which is related to the previous factor, enables the trustee to consider the relative advantages and disadvantages of the alternatives, including a natural recovery alternative, in terms of what is recovered and how rapidly. This factor will be considered together with the previous factor in the plan.

8) Human health and safety This factor requires trustees to consider whether an alternative will have adverse effects on human health and safety.

9) Federal, state, and tribal policies This alternative requires consideration of the degree to which an alternative is consistent with applicable policies.

10) Federal, state, and tribal laws This alternative requires consideration of the degree to which an alternative is consistent with applicable laws.

1.3 The Sites

A brief overview of the activities causing injuries to natural resources and a general description of the injuries may be useful at this point. Further description of the sites and the injuries is also provided in the individual resource chapters.

As is well known, extensive copper mining has taken place in Butte, Montana. Beginning in the 1880s, literally thousands of miles of tunnels were dug to access the ore body. In the 1950s, open-pit mining began with the construction of the Berkeley Pit. When mining and the groundwater pumping required for mining ceased, acid-mine drainage occurred. As a result, the Berkeley Pit, abandoned mine tunnels, and surrounding bedrock contain highly contaminated groundwater.

Mineral processing activities and smelting in Butte have resulted in the disposal of large volumes of tailings, process waters, and other waste products. Infiltration of precipitation through tailings, soils contaminated by process water releases and waste products, and groundwater contact with these materials, cause hazardous substances to be

transported to groundwater.

These past mining activities and disposal practices in the Butte area have resulted in groundwater injury. Injury is demonstrated by, among other things, the fact that groundwater exceeds state and federal drinking water standards for various substances, including arsenic, copper, zinc, cadmium, sulfate, and manganese.

Disposal of tailings, process water, and other waste products in the Butte area also cause surface water contamination. This occurs in two ways. First, Butte Hill groundwater that is not captured by the Pit flows downgradient and discharges to Silver Bow Creek. Thus, contaminated Butte groundwater is a source of contamination for Silver Bow Creek. Second, surface runoff from tailings and waste products transports these materials directly and indirectly to Silver Bow Creek.

A unit of the Silver Bow Creek/Butte Addition NPL site known as Area One demonstrates the complexities of the interactions between various resources. At Area One, buried tailings and waste products at the former site of the Parrot Smelter have contaminated groundwater, which subsequently discharges to Silver Bow Creek. At Lower Area One, tailings and waste products at the former site of the Colorado Smelter and the Butte Reduction Works are located immediately adjacent to Silver Bow Creek. Groundwater, Silver Bow Creek, and waste materials are intimately related at Lower Area One, causing contaminated groundwater to become contaminated surface water. Also, tailings and waste products in the floodplain are continually being rereleased to Silver Bow Creek as a result of surface runoff and streambank erosion.

This pattern of sources releasing hazardous substances to resources, which in turn become sources that rerelease hazardous substances to other resources, is typical. Indeed, this characterization depicts the Upper Clark Fork River Basin--from the upper reaches of the watershed in Butte downstream some 140 miles to Milltown Reservoir.

Silver Bow Creek is contaminated by a number of sources. As discussed above, the Creek receives contaminated Butte groundwater and surface runoff from Butte area sources. In addition, virtually the entire floodplain of Silver Bow Creek is contaminated. Hazardous substances residing in the Creek's floodplain and banks are transported to the Creek from surface runoff and channel erosion. Finally, the bed of the Creek is comprised of

contaminated sediments.

Adjacent to Silver Bow Creek are the former sites of the Montana Pole and Treating Plant and the Rocker Timber and Framing Plant. Groundwater and soil contamination have resulted from releases of hazardous substances at these facilities. Contaminated groundwater from the sites migrates to Silver Bow Creek.

Injury to Silver Bow Creek is demonstrated by, among other things, exceedances of water quality standards, the inability of fish to live in the Creek, lack of aquatic diversity, and loss of riparian resources.

Continuing downstream, 22 miles from Butte, Silver Bow Creek ends at Warm Springs Ponds near the town of Anaconda. The Ponds were constructed to settle out the large volumes of contaminated materials transported downstream by Silver Bow Creek. The collection of sediments in the Ponds has resulted in groundwater contamination beneath and around the Ponds.

Mineral processing and smelting operations in the Anaconda area have also caused significant impacts. Airborne emissions from smelting released large volumes of hazardous substances over a wide area. When these substances were deposited on the land surface, injury to soil, vegetation, wildlife, and wildlife habitat resulted. Operations at Anaconda also produced enormous volumes of tailings, waste water, and waste products generally. These materials were disposed in and around the Anaconda area, most notably at Opportunity Ponds and Anaconda Ponds. As a consequence of this disposal, groundwater in the Anaconda area is contaminated and riparian resources injured.

The Clark Fork River from Warm Springs Ponds to Milltown Reservoir is also contaminated by mining waste. Hazardous substances contained in mining wastes have injured aquatic resources. Floodplain tailings, bed sediments, and poor water quality cause fish populations to be reduced from what they otherwise would be, on average, by a factor of six.

Lastly, at Milltown Reservoir sediments transported downriver from upstream sources have accumulated in significant quantities. This has caused the aquifer underlying, and adjacent to, the reservoir to become contaminated.

While the foregoing discussion introduces the Upper Clark Fork River Basin, it also

illustrates a critical feature of restoration planning and a relevant factor for restoration decision making. The restoration of one part of the system is likely dependant on some other part of the system. Accordingly, it is necessary when devising alternatives, and it will be necessary when selecting alternatives, to consider systemic effects.

1.4 Report Organization

The report identifies restoration alternatives for nine geographic areas and for four general categories of natural resources. The nine geographic areas are: Butte Hill, Area One, Silver Bow Creek, Montana Pole, Rocker, Smelter Hill Area Uplands, Anaconda Area (including Opportunity Ponds, Anaconda Ponds and Warm Springs Ponds), Clark Fork River, and Milltown Reservoir. The natural resource categories are: aquatic resources (surface water, sediments, and aquatic life); riparian resources (soils, vegetation, wildlife, and wildlife habitat); upland resources (soils, vegetation, wildlife, and wildlife habitat); and groundwater resources.

Each chapter begins with a general description of the specific area and its injuries. Next there is a description of the sources of hazardous substances to the injured resources. For restoration to occur, the sources of hazardous substances must be addressed. Each chapter then describes the chosen or anticipated response action and the residual injury to the resource based on the anticipated effects of the response action.

Next, restoration alternatives are proposed. These alternatives include "actions that are needed to bring the injured resources and their services back to baseline . . . in a relatively short period of time" and "actions combined in a manner that would optimize the recovery of all injured resources and services back to their baseline conditions." 56 Fed. Reg. 19757. The alternative of natural recovery is considered for all resource areas.

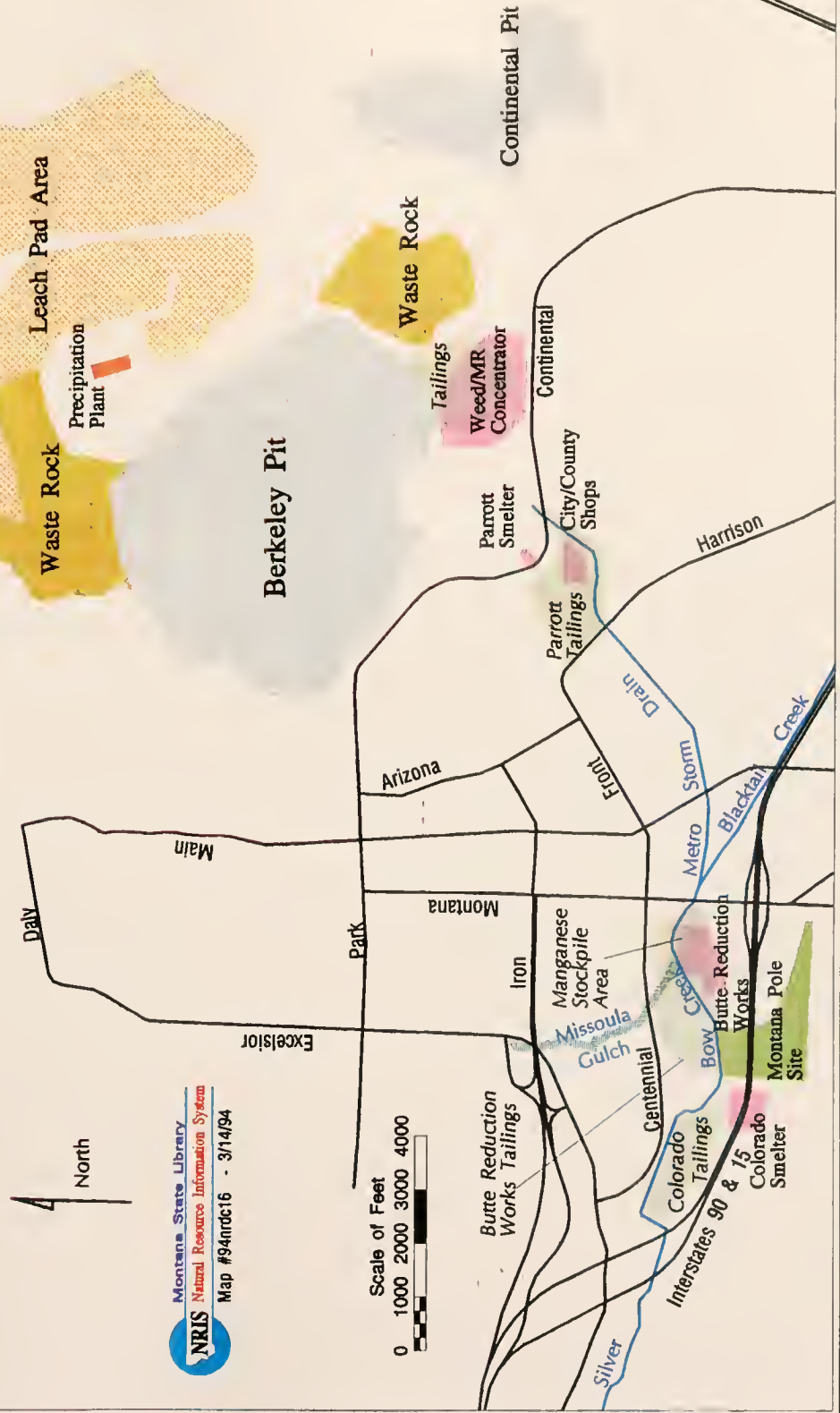
Each alternative proposed will be described and its effects on injured resources discussed. The regulations do not require a specific level of detail; rather the Plan must be sufficiently detailed so as to allow a reasoned evaluation of the alternatives. 43 C.F.R. §11.81(a)(2). As mentioned earlier, an estimate will be made for each alternative of when resources and services will be returned to baseline. Estimates of substantial recovery will also be made. No alternative is designed to exceed baseline.

Lastly, the alternatives will be analyzed based on all relevant factors and compared

against each other. Based on this evaluation the State will select an alternative for each resource chapter. A "brief" explanation--sufficient to understand and evaluate the explanation--of the rationale for selecting a particular alternative will be provided. 56 Fed. Reg. 19756 (col. 3).

Information on the cost of the alternatives is provided in an appendix. The information that was relied on for the cost estimates is referenced and will be included in the administrative record. Issues specific to the cost tables are discussed in an introductory section to the Appendix and in notes that accompany the tables.

Figure 2-1
Butte Hill Site



2.0 BUTTE HILL GROUNDWATER RESOURCES

2.1 Description of Site and Injury

The Berkeley Pit, the adjoining underground mine workings, and the bedrock and alluvial aquifers on Butte Hill represent one of the most contaminated bodies of water associated with a metals mining facility in the world. Combined, this water body presently contains over 60 billion gallons of contaminated water. Levels of hazardous substances in this contaminated water exceed primary and secondary drinking water standards for numerous metals and other contaminants by several hundred to a thousand fold.

Other significant features of the site include the Yankee Doodle Tailings Pond and Dam, the leach pads north of the pit, and various waste rock dumps. These areas continue to be a source of hazardous substances to groundwater.

Mining, which began before the turn of the century, ultimately resulted in an extensive (about 3,000 miles) network of interconnected subsurface workings (tunnels, shafts, etc.). As the mining progressed in depth, groundwater began to accumulate in the mine workings, having migrated from crevices, cracks and fissures in the bedrock. In order to continue mining it soon became necessary to pump this water from the mine workings. During the later stages of underground mining, groundwater was being pumped (at the Kelly Mine shaft) from the mines at rates as high as 7,000 gallons per minute (gpm), or 10.1 million gallons per day (mgd), or 11,300 acre-feet per year.

In the late 1950s, plugs (bulkheads) were installed in the mines to decrease the flow of groundwater between mine workings. The bulkheads resulted in a division of Butte Hill into hydrologic areas: "East Camp" and "West Camp." The East Camp includes the Berkeley Pit, the Kelley, Anselmo, Belmont, Original, Granite Mountain, Lexington, and Steward mines and associated underground mine workings. The West Camp includes the Travona, Emma, and Ophir mine shafts plus associated underground mine workings.

Open pit mining began at the Berkeley Pit in 1955. When mining ceased at the Berkeley Pit in 1982, the bottom of the pit was at an elevation of 4,265 feet above mean sea level (msl). (All elevations cited here are based on USGS datum.) The total depth of the pit, from the bottom to the highest point on the rim, is 1,780 feet; the areal extent of the pit

is approximately 700 acres.

Dewatering the mine workings also kept the pit dewatered. Dewatering, however, ended with the termination of mining in 1982. Consequently, since 1982, as the groundwater has risen toward its pre-mining levels, the pit and mine workings have been filling with contaminated groundwater. The water level in the pit in October 1994 was 5,080 feet, representing a depth of water of 786 feet.

Since the water level in the pit is lower than in the East Camp aquifers which intersect the Berkeley Pit, the groundwater in these aquifers flows towards and into the pit. ARCO studies have indicated that so long as the water level in the East Camp/pit system remains at or below an elevation of 5,410 feet--the "critical water level" (CWL)--the pit and the connected underground workings will serve as a sink and contain Butte Hill's contaminated groundwater. If the water exceeds the CWL, these studies indicate that contaminated groundwater will flow in the aquifer systems away from the pit causing further expansion of the contamination and injury to the Butte ground and surface water systems.¹

The total volume of injured groundwater in the bedrock aquifer (including the underground workings) is estimated to be 119,000 acre-feet; in addition, there is some 74,000 acre-feet of contaminated water in the Berkeley Pit. When the CWL is reached, the volume of contaminated water in the pit is expected to increase to 196,000 acre-feet; at such time the volume of contaminated groundwater in the bedrock aquifer will have increased to about 131,000 acre-feet. Presently the total volume of injured groundwater in the Butte Hill alluvial aquifer is estimated to be 4,860 acre-feet. The areal extent of the injured groundwater in the bedrock aquifer is about 4,133 acres (6.5 square miles) and in the alluvial aquifer is about 505 acres.

2.2 Sources of Hazardous Substances

The Berkeley Pit and underground mine workings intersect the alluvial and bedrock aquifers underlying the Butte Hill area and are important sources of contamination of bedrock

¹ Other experts have opined that groundwater in the alluvial aquifer system may flow away from the pit prior to the CWL being reached. This issue will be addressed during the "Active Mining RI/FS" process.

groundwater. Other sources of contamination for both the bedrock and alluvial aquifers are waste rock, mill tailings, leach pads, leaching solution (with added sulfuric acid), and mill process solutions. Leaching of exposed ore and mine waste, both by circulating groundwater and added sulfuric acid, causes injury to groundwater. Injury is manifested by concentrations of metals and other chemical constituents grossly in excess of drinking water standards. Mining-related processes have resulted in the release of hazardous substances, such as arsenic, beryllium, cadmium, copper, lead, mercury, zinc, sulfuric acid, and sulfides of copper, arsenic, zinc and lead to the groundwater.

The primary mechanism for groundwater contamination in the bedrock aquifer is the leaching of mineralized material, including sulfide minerals and efflorescent salts remaining in underground workings, which generates acid mine drainage. (Acid mine drainage, when circulated in the underground workings and bedrock aquifer dissolves metal sulfides and releases sulfates and metals to the groundwater.)

2.3 CERCLA Response Actions

ARCO is currently subject to the Butte Mine Flooding Operable Unit (BMFOU) administrative order on consent (AO-Docket No. CERCLA VIII-90-09) which requires the water level in the East Camp/pit system to be maintained below the CWL. If the CWL is reached, the pit water must be pumped and treated so that the CWL is not exceeded. Also, a Record of Decision (ROD) was issued by EPA on September 29, 1994 which outlines the remedy for the Butte Mine Flooding Operable Unit.

2.3.1 East Camp Remediation

As stated in the September 29, 1994 ROD, the primary objective of the remedy is to protect human health and the environment from threats posed by the rising contaminated waters in the Butte Mine Flooding Operable Unit. To meet this objective, the remedy is intended to control the inflow of water to the Pit; maintain the ground water in the bedrock system at such a level to preclude the release of contaminants into the alluvial aquifer and the Silver Bow Creek drainage basin; and promote the development of innovative treatment

and/or metals recovery processes in the future.² Outlined below are the major components of the ROD:³

- Permanently controlling and treating 2.4 million gallons of water flowing each day from the Horseshoe Bend area into the Berkeley Pit. Horseshoe Bend is located northeast of the Pit, between the Yankee Doodle Tailings Ponds and the Pit. This water will be kept within the Montana Resources ore processing water circuit while the company is operating, and will be diverted to a newly constructed treatment plant when ore processing is suspended.
- Establishing a comprehensive surface and groundwater monitoring program using wells, shafts, and other locations. Six new bedrock and one additional alluvial well will be drilled to make the monitoring program more complete. The wells will be monitored for water levels and quality and to verify groundwater flow direction. EPA also will monitor numerous private wells in Butte.
- Treating Berkeley Pit water as it approaches the Critical Water level of 5,410 feet. Keeping the water level in the East Camp system below the 5,410 level will prevent it from entering and contaminating the area's alluvial aquifer. EPA expects the water to approach this level in the year 2025, providing that Horseshoe Bend water is diverted.
- Diverting all clean water in the Mine Flooding operable unit around the Pit when mining stops.

2.3.2 West Camp Remediation

The Anaconda Company discontinued dewatering the West Camp mines, via the Emma shaft, in 1965. As a result, the bedrock water level began to rise (to 5,515 ft in the Travona shaft) producing groundwater seeps at the surface and in the basements of houses in Butte. In response, in December 1965 and January 1966, the Anaconda Company drilled and installed "Relief Well No. 21" to alleviate the flooding problem. Well 21 flowed at a rate of about 200 gpm and was discharged into Missoula Gulch for three years. During this

² Declaration for the Record of Decision, dated September 29, 1994, signed by William Yellowtail and Robert J. Robinson.

³ Butte/Walkerville, Montana Superfund Progress Report, December, 1994.

time, the groundwater level elevation in the Travona shaft remained at about 5,475 ft. In the spring of 1969, groundwater stopped flowing from Well 21 and the groundwater level in the Travona shaft dropped considerably.

In May 1982, the groundwater level elevation in the Travona shaft was 5,164 ft. In May 1984, groundwater levels in the West Camp system began to rise again. In response to this renewed mine flooding, EPA implemented the Travona Shaft/West Camp System Expedited Response Action ("Travona ERA"). In April 1989, an administrative order on consent (AOC) was entered as Docket No. CERCLA VIII-89-19, which required the pumping of water from the Travona shaft to maintain the groundwater level in the West Camp system below 5,435 ft. The September 29, 1994 ROD also states that the action taken to control the West Camp water in 1989 is still appropriate and is incorporated into this remedy.

One of the principal purposes of the Travona ERA is to abate the potential for a release of West Camp groundwater, which exceeds water quality criteria for iron, sulfate, and arsenic, into Silver Bow Creek. The 5,435 ft. action level corresponds to the approximate alluvial water level along the creek directly south of Well 21.

In 1989, as part of the Travona ERA, treatability studies were conducted for the purpose of developing a treatment plant for the West Camp water. In late 1989, a pumping and monitoring system was designed, installed, and tested in the Travona shaft. A contract between the PRPs and the Butte/Silver Bow County to allow water to be pumped to the Butte Waste Water Treatment Plant was finalized and pumping began in November of 1989. Under this contract, groundwater is pumped to the treatment plant at about 150 gpm (or about .22 mgd) during about half of each year. (In other words, to keep the water below the 5,435 ft. critical level it is necessary to pump intermittently; in total, this intermittent pumping amounts to 150 gpm over about 6 months out of each year.) This groundwater is mixed with sewage and subsequently treated at the plant. If the Waste Water Treatment Plant cannot continue to accept this water, it will be necessary to treat the water at a different plant or construct another treatment plant to handle this flow.

2.4 Residual Injury

Presumably pumping and treating the pit water and in-flow once the CWL is reached will preclude further contamination of the aquifer systems; however, pumping and treating will not address the continued infiltration of contamination from the existing mine tunnels and other surface and subsurface sources, such as old mine dumps, the pit walls, the Yankee Doodle Tailings Pond, and the leach pads.⁴ Consequently, groundwater in both the alluvial and bedrock aquifers in the Butte Hill area, and in the Pit itself, will continue to be contaminated above drinking water standards by these sources for thousands to tens of thousands of years.

2.5 Restoration Alternatives

2.5.1 Introduction

The September 29, 1994 ROD found that attainment of primary and/or secondary drinking standards in the bedrock aquifer is technically impracticable from an engineering perspective. The principal reasons for this are: 1) the extremely large horizontal and vertical extent of the contamination; 2) the potentially applicable remediation technologies are not proven in conditions similar to this site; and 3) even if one of the potentially applicable technologies were used, the cost of remediation would be inordinately high. It is infeasible to remove one of the major contamination sources, i.e., the billions of cubic yards of partially mined-out bedrock. In addition, the ability to effectively deliver grout or acid neutralizing fluids to the subsurface is very uncertain from an engineering standpoint due to the extremely large extent of underground workings and the improbability of reaching all of the mine workings. Moreover, both grouting of the underground workings and injection of acid neutralizing fluids are prohibitively expensive methods given the conditions at the site (estimated at \$9 to \$11.8 billion, respectively).

Due to the nature and extent of injury, restoration or even substantial recovery of Butte Hill groundwater is not possible. When actual restoration or rehabilitation is not

⁴ Furthermore, there have been a number of studies of the Yankee Doodle Tailings Dam, which, when considered as a whole, are inconclusive as to the seismic safety of the dam. Thus, the State of Montana reserves its rights regarding the potential additional contamination which could be brought about by a dam failure.

possible a trustee can consider alternative methods of redressing the injury. Such a method is a replacement option, or the substitution of a resource for the injured resource.

Alternative No. 2A is a "replacement" option.

2.5.2 Alternative No. 2A

The private well inventory completed for the BMFOU Remedial Investigation indicates that there are more than 800 private and municipal wells within the BMFOU study area. In the "study subarea," which is defined as the portion of the study area "where wells could potentially be impacted by mine flooding waters," there are 140 wells. Thus, groundwater serves as an important source of water in Butte; furthermore, use of groundwater in Butte would be significantly greater if it were not contaminated. The public, however, is precluded from using the contaminated aquifers and water as a water source.

A groundwater resource is also, in essence, an underground reservoir. Such a reservoir offers a number of services beyond the supply of drinking water; such services include water storage and transport. Such services which were once provided by the Butte Hill bedrock and alluvial aquifers have essentially been lost as a result of the contamination.

Accordingly, this alternative considers the functional replacement of the lost resource and the services which the resource once provided. Under this alternative the 327,000 acre-feet of water, which has been or will be lost, would be replaced by other water, and the storage capacity of a portion of the contaminated aquifer would be replaced by surface reservoirs. In other words, under this alternative, new or expanded local reservoirs near Butte would be constructed and filled with replacement water. These reservoirs and water would then be used as a source of domestic and/or irrigation water. Such reservoirs and water could also be used as in-stream flow for fishery enhancement in Silver Bow Creek and the Clark Fork River. (Thus, this alternative can also be viewed as a replacement of the groundwater which would be flowing into Silver Bow Creek if the hydrolic sink created by the Berkeley Pit did not exist.)

The total storage capacity of the replacement reservoirs would be determined based upon the following rationale: In Montana, including the Butte area, it is relatively common for homeowners to drill domestic wells for their personal supply of water as deep as 500

feet. (The well inventory report in the BMFOU RI/FS indicates that wells in the bedrock at Butte Hill have been yielding as much as 50 gpm.) It is estimated that the volume of the bedrock aquifer, which could otherwise be used for domestic wells, that has been lost through contamination is approximately 20,700 acre feet.⁵ In addition, there has been the loss of 4,860 acre-feet of alluvial aquifer on Butte Hill. Thus, this alternative would call for the construction of reservoirs totalling 25,560 acre-feet of storage capacity.

In addition, under this alternative these replacement reservoirs would be supplied, over a 29 year period, with a total of 327,000 acre-feet of water, representing the total volume of water which will be lost due to contamination in the bedrock and alluvial aquifers by the time the CWL is reached. The 29 years used in this alternative represents the time between the construction of the reservoirs, which will presumably occur in 1996, and the year the CWL is expected to be reached, i.e., 2025. This alternative also assumes that equal amount of the 327,000 acre-feet of water will be replaced each year, i.e., that there would be 11,275 acre-feet of replacement water supplied to the new reservoirs each year between 1996 and 2025.

2.5.3 Alternative No. 2B

Under this alternative the potential responsible parties (PRPs) would pay a sum certain for the purpose of helping to pay for the upgrading of the Butte water supply system.

In recent years Butte has been forced by the condition of its antiquated water system to expend tens of millions of dollars on upgrading its system. (Further upgrades of the system, including the delivery system, may also be necessary.) As a result, the citizens of Butte now are subject to the highest water rates in Montana and are liable for the repayment of millions of dollars of bonded debt.

It was recognized at the time plans were being considered that an alternative to upgrading the entire system would be greater reliance on groundwater wells for domestic

⁵ This value was estimated by multiplying the areal extent of bedrock contamination, times four hundred and fifty feet, times the estimated porosity: $4,600 \text{ acres} * 450 \text{ feet} * .01 = 20,700 \text{ acre feet}$. This number, which assumes the top 50 feet would not contain water, is believed to be conservative: The upper portions of the bedrock aquifer should have a higher porosity and it is likely that domestic wells could be drilled deeper than 500 feet.

supply. However, this alternative was rejected, in part, because of the infeasibility of relying on contaminated aquifers as a drinking water source. Thus, in effect, the upgraded system, plus any future additions thereto, represents a replacement of the services which would have otherwise been available from the aquifers underlying Butte if they were not contaminated. Therefore, payment by the PRPs of a monetary sum to upgrade the water system is a justifiable replacement alternative.

Dr. John Duffield, of Bioeconomics, Inc., in the report, *Literature Review and Estimation of Municipal and Agricultural Values of Groundwater Use in the Upper Clark Fork River Drainage*, March 18, 1994, estimates the present value of future losses to residential users in Butte resulting from the inability to utilize groundwater wells to be \$31,607,695. Thus, it is this amount which would be paid to the trustee under Alternative 2B as a replacement cost for the water resource services which should have been available from the Butte Hill aquifers. This amount would then be used to further upgrade the Butte water system and/or repay the outstanding bonded indebtedness previously paid for the upgrade.

2.5.3 Alternative No. 2C

Under the no action alternative, monitoring of shafts and monitoring wells would be performed to evaluate the natural recovery. No further restoration actions would occur beyond the remedy. The level of water in the Berkeley Pit would be maintained at or below the CWL of 5410 feet. This response action will not restore the resource; in fact, the condition of the resource will get worse. The existing volume of injured groundwater, approximately 194,000 acre-feet, will increase to 327,000 acre-feet within 30 years. Natural recovery of resources and services to baseline would take thousands of years.

2.6 Evaluation of Alternatives

2.6.1 Technical Feasibility

Alternatives 2A and 2B are both readily feasible from a technical standpoint. Both alternatives call for the replacement of the contaminated groundwater underlying the Butte Hill area. More specifically, Alternative 2A calls for constructing new or expanding local reservoirs near Butte. Also, under this alternative a supply of water, about 10 mgd, would

be provided to the new and/or expanded reservoirs. These reservoirs and water would then be used for storage and as a source of domestic and irrigation water. Such reservoirs and water could also be used as a source of in-stream flow for fishery enhancement in Silver Bow Creek and the Clark Fork River. Thus, this alternative can also be viewed as a replacement of groundwater which would be flowing into Silver Bow Creek if the hydrolic sink created by the Berkeley Pit did not exist. Under Alternative 2B, the money obtained would be used to further upgrade the existing Butte water system or to repay the outstanding bonded indebtedness previously paid for the system upgrade.

2.6.2 Cost-effectiveness

The distinctions between Alternatives 2A and 2B cannot be analyzed on a cost-effectiveness basis because the alternatives do not provide a similar level of benefits.

2.6.3 Results of Response Actions

The principal response action for this site, i.e., pumping and treating the Pit water once the Critical Water Level (CWL) is reached, is predicted to begin in approximately 30 years, i.e., by the year 2025. This pumping and treating should preclude further expansion of contamination within the aquifer systems; it will not address the existing contamination. Consequently, the groundwater and both the alluvial and bedrock aquifers in the Butte Hill area and in the Pit itself will continue to be contaminated. In fact, as the Pit continues to fill, the amount of contaminated water will almost double between now and the year 2025. It is not likely that the proposed replacement alternatives for this site will not have any effect on the response actions or create a need to coordinate with such actions.

2.6.4 Potential for Additional Injury

Additional injury to the groundwater resources from these alternatives is not expected. Both Alternative A and B involve construction of certain facilities. Thus, the potential impacts from these alternatives consist of the usual impacts from any construction activity. It is assumed that the potential environmental impacts will be considered and mitigated as part of the planning phases of any construction projects arising from these alternatives.

2.6.5 Natural Recovery and the Ability of the Resource to Recover

The Record of Decision (ROD) for this site found that the attainment of primary

and/or secondary drinking water standards in the bedrock aquifer is technically impractical from an engineering perspective. In addition, due to the extremely elevated concentrations of hazardous substances in the groundwater and the great areal extent and volume of contamination, natural recovery of the groundwater resources would take from thousands to tens of thousands of years. While the resource itself will not recover, both Alternatives 2A and 2B will replace some of the services lost as a result of the contamination. Such services will include replacement water which can be used for drinking, irrigation and instream flow; also, under Alternative 2A, such services will include replaced water storage capacity.

2.6.6 Human Health and Safety

There are few health and safety concerns associated with the alternatives. Alternatives 2A and 2B would involve construction and thus the normal human safety risks would be attendant. However, these risks can be minimized by the compliance with all applicable laws and regulations governing work place safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected.

2.6.7 Federal, State, and Tribal Policies

There are no applicable federal, state or tribal policies which would be adversely implicated by any of these alternatives. Alternative 2A, in fact, would promote the natural resource policies of the State of Montana by enhancing the fishery of Silver Bow Creek and ultimately the Clark Fork River.

2.6.8 Federal, State, and Tribal Laws

The State would obtain all necessary permits and authorizations before implementing any projects under Alternatives A or B.

2.6.9 Other Relevant Factors

In considering the alternatives, one cannot help but consider the extreme nature and extent of the groundwater contamination. This contamination underlays an area of more than seven square miles, which is substantially residential and commercial, near the center of the city of Butte. This area, in fact, has a population of over 10,000 people. As a result of the contamination, however, the people living in this area are forever precluded from using the groundwater below their properties as a source of water. The costs of both Alternative 2A and 2B are small compared to the cost it would take to restore the groundwater resource if

that were feasible, and are minimal when compared to the total value taken out of the ground as part of the mining which caused the contamination.

2.6.10 Cost-Benefit/Decisionmaking Analysis

The cost of the alternatives are as follows: Alternative 2A--\$61 million (see Appendix); Alternative 2B--\$32 million; and Alternative 2C--\$1.2 million (see Appendix). Based on the following analysis and the foregoing discussion, the State selects Alternative 2A.

While both alternatives will replace, in part, the lost resources, Alternative A will more fully do the job. This alternative will provide an additional 25,500 acre-feet of reservoir storage to the Butte area, and an additional water supply of 10 mgd for the next 29 years.⁶ Not only can this water be used to meet drinking water and irrigation demands (and particularly demands created by an expanding population) it can also supply in-stream flow to Silver Bow Creek. In doing so, the Alternative 2A replacement will also enhance the injured fishery of Silver Bow Creek and replace the water which would flow into the Creek, if the contaminated Berkeley Pit did not exist.

The cost of the replacement reservoir(s) under Alternative 2A is reasonable, particularly when one considers that only a small portion, i.e., some 20%, of the total storage capacity of the contaminated aquifers which has been lost, is being replaced. Also, this cost does not even consider the supply and transmission services of the aquifer which have been forever lost. Alternative 2B is some \$30 million less expensive than Alternative 2A, but the benefits to be gained would be also significantly less. Also, the work to be done, or the bonded indebtedness to be repaid, which is proposed under Alternative 2B, will likely be done or repaid whether or not the alternative is implemented.

⁶ Note, after 29 years it is expected that a similar quantity of water will be supplied to Silver Bow Creek as a result of the treatment of Berkeley Pit water as part of the E.P.A. remediation. Thus, Alternative A, in effect, will implement one of the major benefits of the EPA remediation some 29 years in advance.



Figure 3-1.
Butte, Montana
Area One
Features

3.0 AREA ONE GROUNDWATER AND SURFACE WATER RESOURCES

3.1 Description of Site and Injury

The deposition of wastes in the city of Butte from mining and mineral-processing operations has resulted in injury to groundwater resources and surface water resources of Silver Bow Creek. This chapter focuses on Area One, which is part of the Silver Bow Creek/Butte Addition NPL site. Area One extends from the upper end of the Metro Storm Drain to the west (downstream) end of the Colorado Tailings. The portion of Area One that contains the Colorado Tailings and the Butte Reduction Works, and the adjacent reach of Silver Bow Creek, is known as Lower Area One (LAO). Silver Bow Creek is formed by the confluence of Blacktail Creek and the Metro Storm Drain. Blacktail Creek flows year-round and comprises a large part of the flow of Silver Bow Creek.

The injured groundwater aquifers in Butte are a bedrock aquifer on Butte Hill, an alluvial aquifer on Butte Hill, and an alluvial aquifer along the Metro Storm Drain and Silver Bow Creek. The Butte Hill bedrock and alluvial aquifers are discussed in Chapter 2. The alluvial aquifer along the Metro Storm Drain and Silver Bow Creek is discussed in this chapter.

Injury to groundwater has been demonstrated by the occurrence of concentrations of heavy metals (including cadmium, zinc, iron, lead, and copper), arsenic, and sulfate that exceed drinking water standards. The areal extent of contamination of the alluvial aquifer is estimated to be 562 acres, based on the size of the largest contaminant plume (sulfate). The total volume of injured groundwater is estimated to be 11,590 acre-feet, and the annual flux (or discharge to Silver Bow Creek) is estimated to be 2,353 acre-feet per year.

Silver Bow Creek is contaminated by the discharge of contaminated groundwater and by surface runoff. The Metro Storm Drain receives surface runoff during snowmelt and storm events and intercepts contaminated groundwater. Although the Metro Storm Drain contributes much less flow to Silver Bow Creek than does Blacktail Creek, it contributes far more contamination to Silver Bow Creek than does Blacktail Creek. Groundwater in the Metro Storm Drain area flows towards LAO and discharges, as noted, to the Metro Storm Drain, upper Silver Bow Creek, and possibly Blacktail Creek. Contaminated surface water

ORIGINAL ARTICLES

THE EFFECT OF VITAMIN DEFICIENCY ON THE GROWTH OF THE RAT

BY J. H. HOLLAND, JR., M.D., AND J. H. HOLLAND, JR., M.D.

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in Silver Bow Creek flows downstream from Area One and is therefore a source of hazardous substances to injured aquatic resources downstream.

3.2 Sources of Hazardous Substances

Since the late 1800s, disposal practices from mining and milling operations in Butte have resulted in the presence of tailings and other mining-related wastes along the Metro Storm Drain, Silver Bow Creek, and throughout the city of Butte. Much of the waste is associated with three former facilities -- the Parrot Smelter, the Butte Reduction Works, and the Colorado Smelter. The Parrot Tailings lie along and northwest of the Metro Storm Drain above Harrison Avenue. The Butte Reduction Works Tailings and the Colorado Tailings lie adjacent to Silver Bow Creek in LAO. Tailings probably associated with the Parrot Smelter occur along the Metro Storm Drain between Harrison Avenue and Silver Bow Creek. In addition to these waste sources, dispersed surficial and buried tailings, mine and mill sites, dumps, and contaminated fill areas are located throughout Butte.

Groundwater at Area One occurs in three ways: 1) by the leaching of hazardous substances in the unsaturated zone to downgradient groundwater via infiltration of precipitation or rising capillary groundwater; 2) by the leaching of hazardous substances in the saturated zone via groundwater contact with sources; and 3) by the transport of water containing hazardous substances through the unsaturated or saturated zone to downgradient groundwater.

Surface water contamination results from the discharge of contaminated groundwater and from contaminated surface runoff. Alluvial groundwater discharges to Silver Bow Creek at an average rate of approximately 3.25 cubic feet per second (cfs). Surface runoff from storms and snowmelt carries hazardous substances from dispersed waste sources in Butte to Silver Bow Creek through surface drainages and the Butte stormwater collection system. This runoff, which also transports contaminated sediment, contributes to the contamination of surface water and streambed sediments in Silver Bow Creek.

3.3 CERCLA Response Actions

At the present time, an Expedited Response Action (ERA) is occurring at LAO. Approximately 1.4 million cubic yards of tailings and contaminated soils will be removed

from the Butte Reduction Works Tailings and the Colorado Tailings. This volume includes tailings (230,000 cubic yards) and contaminated soils (370,000 cubic yards) at the Colorado Tailings; and tailings (240,000 cubic yards), railroad fill (130,000 cubic yards), and contaminated soils (430,000 cubic yards) at the Butte Reduction Works.

Additional response actions planned or anticipated at Area One will address contaminated surface runoff to Silver Bow Creek by surface drainages and the stormwater system, and discharges to Silver Bow Creek of contaminated groundwater. A Record of Decision (ROD) selecting the remedy is anticipated in 1999. Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that the following actions are likely to be implemented at Area One:

- 1) diverting clean groundwater around the Colorado Tailings site through an interception trench;
- 2) collecting contaminated groundwater downgradient of the Colorado Tailings, the Butte Wastewater Treatment Plant (WWTP) and slag walls, and the Parrot Tailings;
- 3) treating 500 gallons per minute of contaminated groundwater at a treatment facility at LAO;
- 4) removing 123,000 cubic yards of tailings along the Metro Storm Drain between Kaw Avenue and Silver Bow Creek and realigning the Metro Storm Drain within this reach;
- 5) removing and reconstructing the Silver Bow Creek stream channel between the upstream end of the Colorado Tailings and the Metro Storm Drain;
- 6) reconstructing Silver Bow Creek to its approximate historic alignment through the Colorado Tailings area;
- 7) removing and/or reclaiming waste dumps and mining/milling sites in the uptown Butte area; and,
- 8) constructing a stormwater runoff detention basin to intercept and treat surface runoff from surface drainages and the stormwater collection system.

The primary objective of remedial actions is to reduce releases of hazardous substances to Silver Bow Creek by intercepting and treating contaminated groundwater and contaminated surface runoff.

3.4 Residual Injury

The remedy will not return injured resources to baseline, nor is it intended to. After implementation of the remedy approximately 800,000 cubic yards of tailings and contaminated soils at the Butte Reduction Works will remain under the grounds of the Butte WWTP and the slag walls and continue to contaminate groundwater. Approximately 77,000 cubic yards of tailings along the Metro Storm Drain between Harrison Ave and Silver Bow Creek and 190,000 cubic yards of the Parrot Tailings will not be removed and will continue to contaminate groundwater. Despite response actions at the Colorado Tailings, hazardous substances will remain and continue to contaminate groundwater.

Thus, response actions will not restore groundwater to baseline conditions. It is likely that plumes of arsenic, lead, and copper will continue to increase in size. Hazardous substance concentrations will remain well above drinking water standards and baseline conditions.

Tailings removal at LAO will reduce loadings of hazardous substances from groundwater discharge to this reach of Silver Bow Creek by approximately 65 percent. Copper concentrations in Silver Bow Creek will be between 55 and 70 ug/l during base flow, which will exceed both ambient water quality criteria (by a factor of approximately four) and baseline conditions. Additional response actions, in the form of collection systems at various locations that will intercept and treat groundwater and surface runoff, will further reduce loadings of hazardous substances to Silver Bow Creek. However, the discharge of contaminated groundwater to Silver Bow Creek will not be eliminated because contaminated groundwater will continue to discharge directly through the bed of the Creek. Finally, the ubiquitous and widespread extent of surface contamination throughout the Butte area will ensure that surface runoff will transport some amount of contaminated sediment to Silver Bow Creek.

3.5 Restoration Alternatives

3.5.1 Introduction

Distinctions between types of wastes are useful in understanding Area One restoration alternatives. Wastes can be broken into three types: primary sources, secondary sources, and diffuse surface and subsurface sources. Primary sources are directly derived from mining and mineral processing operations. Primary sources include tailings deposits such as the Parrot Tailings. Primary sources contain copper and other metal sulfide mineralization. Secondary sources are derived from the deposition of hazardous substances leached from sulfide minerals in primary sources. Secondary sources include contaminated soils and aquifer materials. Diffuse surface and subsurface sources are largely primary sources. These are scattered throughout Butte and are of an unknown volume and location.

Restoration alternatives do not attempt to address, except indirectly, secondary sources or diffuse sources. There are substantial difficulties associated with removing secondary sources, which can extend to great depths and over large areas of the alluvial aquifer. Removal of diffuse sources is problematic for the obvious reason that their locations are not known.

Groundwater restoration can be achieved by removing primary sources and by natural recovery. However, given the widespread extent of diffuse surface and subsurface waste sources, and the extent of secondary contamination of soils and aquifer materials, resources and services will not be restored to baseline conditions for the foreseeable future under any alternative. These diffuse and secondary sources will continue releasing hazardous substances to groundwater for thousands of years. Consequently, restoration alternatives are focussed primarily on improving the condition of the resource and the services it provides relative to its existing condition, and secondarily on accelerating the time frame for restoration.

Although restoration alternatives favor removal actions, consideration was given to other treatment techniques like groundwater flushing or *in-situ* leaching. But, due to concerns and uncertainties over the efficacy of such techniques, and given the geochemical characteristics of the sources and the geohydrological characteristics of the site, such techniques were rejected for further analysis.

As discussed in Section 1.2.2, restoration planning will be coordinated, to the maximum possible extent, with response action planning. The Natural Resource Damage Litigation Program (NRDLP) will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action.

3.5.2 Alternative 3A

This alternative would remove known primary waste sources to reduce releases of hazardous substances to groundwater and surface water. The key elements of this alternative are:

- 1) excavating tailings beneath the grounds of the Butte WWTP and the slag walls;
- 2) excavating the Parrot Tailings;
- 3) excavating tailings in the Metro Storm Drain between Harrison Avenue and Kaw Avenue;
- 4) disposing of excavated wastes at the Anaconda and/or Opportunity Ponds;
- 5) backfilling excavated areas of the Butte Reduction Works and the Metro Storm Drain and with clean material;
- 6) rebuilding the City-County Shop Complex;
- 7) installing a groundwater interception trench parallel to the Metro Storm Drain and Silver Bow Creek to the upstream end of the Colorado Tailings;
- 8) treating intercepted groundwater at a treatment facility; and,
- 9) natural recovery.

All tailings and associated contaminated soils remaining after remedy would be removed. Estimated volumes include 800,000 cubic yards of Butte Reduction Works Tailings and contaminated soils, 190,000 cubic yards of the Parrot Tailings, and 77,000 cubic yards of tailings in the lower Metro Storm Drain between Harrison Avenue and Kaw Avenue. About 840,000 cubic yards of overburden at the Parrot Tailings and 112,000 cubic yards of overburden in the Metro Storm Drain would be excavated, stockpiled, and backfilled.

To excavate these tailings, it will be necessary to remove the City-County Shop Complex. The City-County Shop Complex could be used while that part of the Parrot

Tailings not underlying the Complex was removed. Excavated materials would be disposed of at the Anaconda and/or Opportunity Ponds. Tailings beneath the grounds of the Butte WWTP would be excavated from around site structures. Structures would remain in place. All, some, or sections of the slag walls would be removed depending on the results of site investigations and confirmation of contamination beneath the slag walls. Excavated areas would be backfilled with the stockpiled overburden and clean material to maintain the existing surface elevation and grade.

A groundwater interception trench would be constructed parallel to the Metro Storm Drain and Silver Bow Creek. This trench would intercept contaminated groundwater that would otherwise discharge to Silver Bow Creek by way of the Metro Storm Drain or by way of the streambed.

Intercepted groundwater would be treated at the treatment facility at the lower end of the Colorado Tailings. The 500 gallons per minute (approximately one cfs) treatment facility constructed under remedy would be expanded by 2.25 cfs. Treated water would be pumped back and discharged to the headwaters of Silver Bow Creek to maintain instream flows.

Under this alternative, impacts to surface water would be significantly reduced. Groundwater interception trenches, and treatment of contaminated groundwater at the treatment facility, would virtually eliminate the discharge of contaminated water to Silver Bow Creek. However, groundwater contamination will exist for a significant length of time. As noted, diffuse primary surface and subsurface waste sources are present throughout the Butte area; secondary contamination of soils and aquifer materials is extensive. Natural recovery would be relied upon to decrease loadings from remaining primary and secondary sources and restore resources and services to baseline conditions. Under this alternative, resources and services would not be restored to baseline for a few thousand years.

Nonetheless, this alternative would significantly improve the condition of injured groundwater by reducing concentrations of hazardous substances. This substantial recovery would be manifested shortly after the excavation of waste sources. In addition, portions of the contaminated aquifer would return to drinking water standards within approximately 200 years as natural weathering processes gradually decrease remaining primary and secondary sources of contamination.

3.5.3 Alternative 3B

This alternative focuses on the removal of the Parrot and Metro Storm Drain tailings, and intercepting and treating contaminated groundwater discharges to Silver Bow Creek.

The key elements of this alternative are:

- 1) excavating the Parrot Tailings;
- 2) excavating tailings in the Metro Storm Drain between Harrison Avenue and Kaw Avenue;
- 3) disposing of excavated wastes at the Anaconda and/or Opportunity Ponds;
- 4) backfilling excavated areas of the Metro Storm Drain with clean material;
- 5) installing a groundwater interception trench parallel to the Metro Storm Drain and Silver Bow Creek to the upstream end of the Colorado Tailings;
- 6) treating intercepted groundwater at a treatment facility; and,
- 7) natural recovery.

This alternative differs from Alternative 3A in one respect. The Butte Reduction Works tailings would be left in place. This volume is approximately 800,000 cubic yards of tailings, contaminated soils and other wastes. No further action beyond the response action would address these wastes. As in Alternative 3A, the 267,000 cubic yards of the Parrot and Metro Storm Drain tailings would be excavated.

This alternative reduces impacts to surface water to roughly the same degree as Alternative 3A by intercepting and treating virtually all of the contaminated groundwater that discharges to Silver Bow Creek. Therefore, under this alternative, surface water contamination would be reduced to the same extent and in the same time frame as under Alternative 3A. However, as discussed in the next paragraph, the treatment plant will be needed for a significantly longer period of time under this alternative than it will be needed under Alternative 3A.

Like Alternative 3A, removal of the Parrot and Metro Storm Drain tailings would result in substantial recovery in groundwater water quality in portions of the alluvial aquifer affected by these waste sources. This recovery would be manifested shortly after removal of these waste sources. Within approximately 200 years, portions of the contaminated aquifer affected by these waste sources could return to drinking water standards as weathering

processes gradually decrease remaining associated secondary contamination. In other portions of the alluvial aquifer affected by the large volume of primary wastes (800,000 cubic yards) and associated secondary contamination that would be left in place at the Butte Reduction Works, groundwater contamination will remain. This will require the treatment facility to operate for a much longer period of time to treat contaminated groundwater collected by the interception trench than the treatment plant will operate under Alternative 3A.

Restoration would take substantially longer under this alternative than under Alternative 3A, given the larger volume of primary source material not removed under this alternative as compared to Alternative 3A. With more primary source material remaining under this alternative, primarily the 800,000 cubic yards of tailings at the Butte Reduction Works, more time would be required for oxidation and leaching mechanisms to remove the greater quantity of hazardous substances associated with sulfide minerals. Restoration to baseline would not occur for thousands of years.

3.5.4 Alternative 3C

In this alternative, no further action is taken at the site beyond the CERCLA response action. Silver Bow Creek would be a significant source of hazardous substances to resources downstream because contaminated groundwater would continue to discharge to the Creek.

Natural weathering processes would be relied upon to restore groundwater to baseline conditions. As described in Section 3.4, groundwater contamination would likely become worse for some period of time as contaminant plumes increase in size. Over thousands of years, contaminant concentrations in groundwater would decrease as leaching mechanisms deplete the supply of hazardous substances in primary sources, namely the Butte Reduction Works Tailings, the Metro Storm Drain Tailings, and the Parrot Tailings. At this time, contaminant concentrations in groundwater would be reduced to roughly the same level as achieved under Alternative 3A shortly after removal. However under this alternative, as under Alternative 3A, secondary contamination would remain even after primary sources are addressed. Restoration would require another few thousand years to transport secondary source contamination out of the aquifer. Thus, restoration of resources and service flows to baseline would not occur for tens of thousands of years.

3.6 Evaluation of Alternatives

3.6.1 Technical Feasibility

Alternatives 3A, 3B, and 3C are equivalent in terms of technical feasibility.

Alternative 3C, which calls for monitoring and natural recovery, is technically feasible. With respect to the other two alternatives, both alternatives equally employ well-known and accepted technologies and both have a reasonable chance of successful completion in an acceptable period of time. All of the elements of both action alternatives are presently being employed or will be employed in the Upper Clark Fork Basin. Removal of tailings and contaminated soils addresses contamination to groundwater and surface water. An expedited response action involving the removal of tailings and contaminated soils is ongoing at LAO, the precise location of removal actions proposed under Alternatives 4A and 4B. Disposal of contaminated materials at Anaconda and/or Opportunity Ponds is occurring in conjunction with the ongoing response action. The construction of an interception trench to capture contaminated groundwater and prevent its discharge to surface water is also an accepted technology. Finally, construction of a treatment plant to remove metals from groundwater is unremarkable. A treatment plant is estimated to occur under remedy to address groundwater impacts at LAO, and a treatment plant is planned under the Berkeley Pit mine flooding ROD.

3.6.2 Cost effectiveness

A distinction between Alternatives 3A, 3B, and 3C cannot be made on cost-effectiveness grounds because the alternatives do not provide a similar level of benefits. For example, under Alternative 3A a significantly larger portion of the alluvial aquifer would benefit from the removal of contaminant sources than will benefit under Alternatives 3B and 3C. With the removal of the Parrot Tailings, Butte Reduction Works Tailings, and Metro Storm Drain Tailings, Alternative 3A significantly improves the condition of the alluvial aquifer in those areas shortly after excavation is completed. Removal of these sources would lead to the recovery of drinking water standards for those portions of the alluvial aquifer within approximately 200 years. Alternative 3B is comparable to Alternative 3A insofar as recovery of those parts of the alluvial aquifer impacted by the Parrot Tailings and the Metro Storm Drain Tailings. But, under Alternative 3B significant reductions in groundwater contaminant concentrations would not occur in the alluvial aquifer at LAO and drinking

water standards for this area would not return for centuries or longer. And, while Alternative 3C is comparable to Alternative 3B with respect to the alluvial aquifer at LAO, Alternative 3C does nothing to improve the condition of the alluvial aquifer affected by the Parrot and Metro Storm Drain Tailings.

Another difference between the alternatives concerns the treatment plant. As discussed above, the interception trench and treatment plant are necessary to eliminate the discharge of contaminated groundwater to Silver Bow Creek in order to enable that surface water resource to recover. Alternative 3C does not provide for such a plant. Thus, there is a significant difference in benefits derived from this alternative vis a vis Alternatives 3A and 3B. In addition, although a treatment plant is an element under both Alternatives 3A and 3B, the length of time such a plant will need to operate will be significantly less under Alternative 3A than Alternative 3B because removing 800,000 cubic yards of Butte Reduction Tailings and contaminated soils under Alternative 3A will enhance recovery times for groundwater. This is significant because treatment plants are expensive to operate, need to be maintained, and must be reconstructed every fifty years or so. Consequently, Alternatives 3A and 3B produce a different level of benefits when the alternatives are compared in light of the need for the treatment plant.

3.6.3 Results of Response Actions

As discussed, the response actions that have occurred, are on-going, or are estimated to occur at this site will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources. Thus, for example, it is critical to eliminate the discharge of contaminated groundwater to Silver Bow Creek to enable the Creek to recover.

Neither Alternatives 3A or 3B conflicts with actual or planned response actions. However, both alternatives must be coordinated with anticipated response actions. This plan assumes such coordination will occur and costs are assigned to various actions under these alternatives accordingly.

Consequently, it is not possible to draw distinctions between these alternatives based on issues related to the integration of these alternatives with estimated response actions. Should it become evident that it will be impossible to coordinate either restoration alternative

with the response action, this plan will be revised.

3.6.4 Potential for Additional Injury

The implementation of either Alternative 3A or 3B will result in only minor environmental harm. Furthermore these impacts will be transitory. The potential impacts from the alternatives consist of the usual impacts from any construction activity. There will be particulate matter released from the areas being excavated and construction sites, runoff from these areas to surface water, and additional air pollution from the operation of heavy equipment. Impacts will be mitigated to the fullest possible extent through the use of standard construction practices such as wetting down a site and installing silt fences. These impacts are expected to be minor. Due to the greater amount of excavation under Alternative 3A than Alternative 3B, whatever impacts occur will likely be greater under Alternative 3A than under Alternative 3B.

There will also be minor impacts associated with the disposal of sludges from the treatment plant. Impacts will be greater under Alternative 3B than Alternative 3A due to the longer period of time needed for the treatment plant under Alternative 3B.

Both short-term and long-term environmental impacts are expected to be significantly more severe and significantly greater under Alternative 3C than under either Alternatives 3A or 3B. This result will obtain because under Alternative 3C impacts to Silver Bow Creek and to the alluvial aquifer will continue unabated.

3.6.5 Natural Recovery and the Ability of the Resource to Recover

Under natural recovery, or Alternative 3C, groundwater will not be restored to baseline for tens of thousands of years and the discharge of highly contaminated groundwater to Silver Bow Creek will continue indefinitely. Alternatives 3A and 3B reduce the time to baseline by removing source materials. Baseline will be reached sooner under Alternative 3A than Alternative 3B, because Alternative 3A removes more contamination than Alternative 3B.

Significant differences between these alternatives in terms of recovery periods also arise in the consideration of substantial recovery for groundwater and impacts to Silver Bow Creek. With respect to the later, Alternative 3C would prevent Silver Bow Creek from

recovering for centuries if not thousands of years due to the fact that contaminated groundwater will continue to discharge to the Creek. Under Alternatives 3A and 3B, interception and treatment of contaminated groundwater will virtually eliminate impacts to Silver Bow Creek immediately after construction of the interception trench. With respect to the former-substantial recovery to drinking water standards--under Alternative 3B recovery to drinking water standards for that portion of the alluvial aquifer affected by Butte Reduction Works sources would not occur for hundreds, if not thousands, of years, whereas under Alternative 3A the alluvial aquifer would attain drinking water standards in approximately 200 years.

3.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Since Alternative 3C entails no excavation or construction, this alternative would avoid any risks inherent in the undertaking of such activities. These risks, to the extent they exist under Alternatives 3A and 3B, will be minimized by compliance with all applicable laws and regulations governing workplace safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected.

3.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

3.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

3.6.9 Other Relevant Factors

The slag walls in LAO are an historical artifact of the city of Butte. Alternative 3A allows for the possibility of removal of some, all, or portions of the slag walls to access tailings. Alternatives 3B and 3C do not create the potential for slag wall removal.

In the course of planning its expedited response action for LAO, the U.S. EPA encountered a degree of community opposition to the disposal of tailings at the Opportunity Ponds. All of the action alternatives call for disposal of tailings and contaminated soils at Opportunity and/or Anaconda Ponds. Decisions regarding disposal will be made during the

preparation and implementation of a Restoration Plan.

3.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 3A--\$59.7 million; Alternative 3B--\$34.8 million; and Alternative 3C--\$.9 million. Based on the following analysis, and informed by the previous discussion, the State selects Alternative 3A.

The alternative's costs must be looked at side-by-side with the previous discussion. In the final analysis, the severity of the injury to groundwater and surface water combined with the prospects that these injuries would continue for thousands of years was dispositive. Alternative 3C was unacceptable for this reason.

Alternative 3A resulted in a greater volume and areal extent of groundwater attaining substantial recovery than will occur under Alternative 3B. This was deemed important in choosing between these two alternatives. Equally important was the fact that under Alternative 3B the treatment plant would have to operate for a much longer period of time.

The consequence of removing the slag walls was also considered. Due to the severity of the injury and the benefits to be obtained from removing tailings and contaminated soils at the former site of the Butte Reduction Works, maintaining the integrity of the slag walls was determined to be of secondary importance. Furthermore, to reject Alternative 3A on this basis would have given the issue undue importance given that the slag walls may not need to be disturbed depending on the results of site investigations.

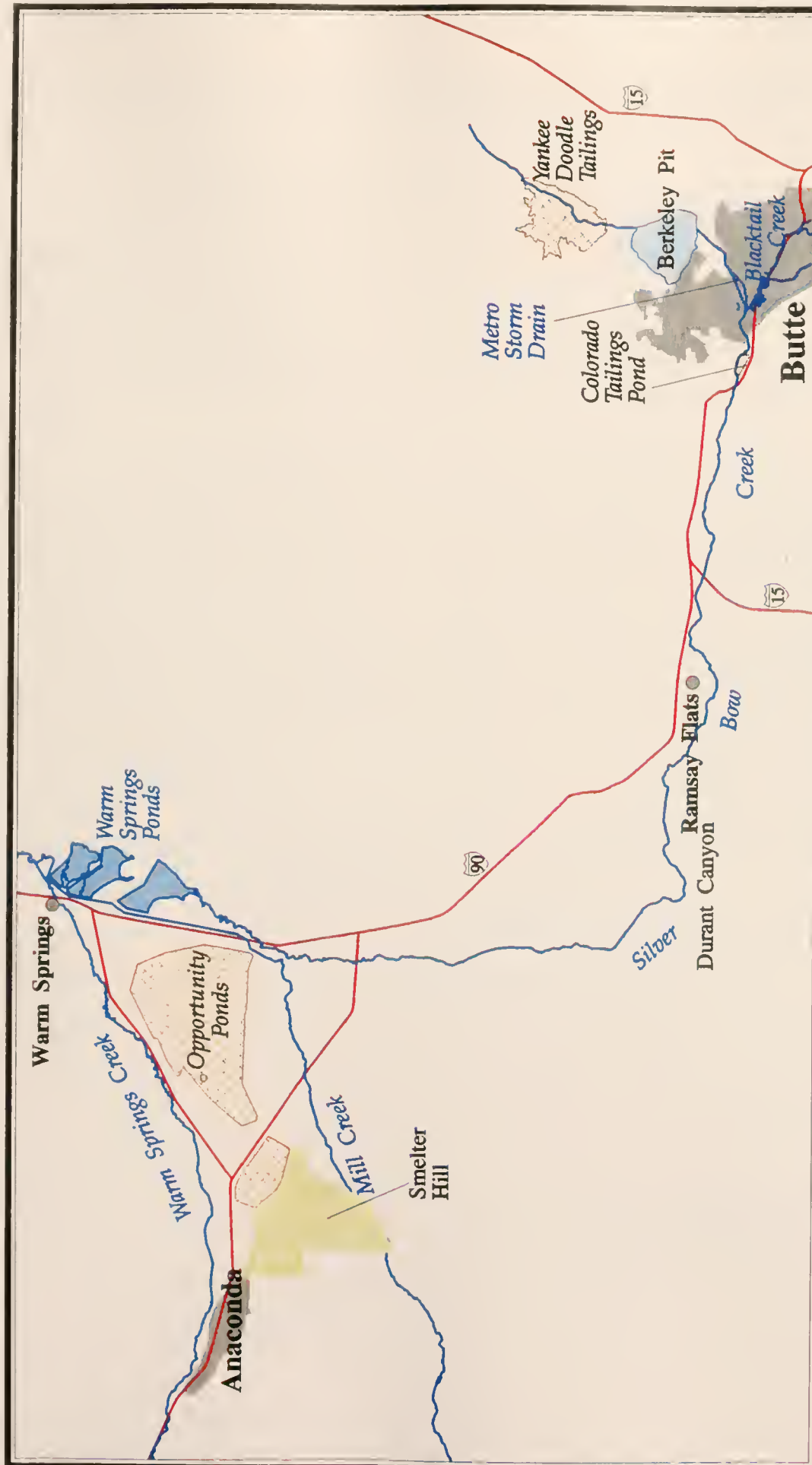
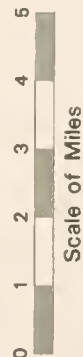


Figure 4-1. Silver Bow Creek



4.0 SILVER BOW CREEK AQUATIC AND RIPARIAN RESOURCES

4.1 Description of Site and Injury

Aquatic and riparian resources of Silver Bow Creek have been injured by the hazardous substances arsenic, cadmium, copper, lead, and zinc released from mining and mineral-processing operations in the Butte area. Silver Bow Creek is a unit within the Silver Bow Creek/Butte Addition NPL site. As defined here, Silver Bow Creek extends from the lower end of the Colorado Tailings to Warm Springs Ponds--a distance of approximately 23 miles.

Since the late 1800s, tailings and other mining wastes containing hazardous substances have been discharged to Silver Bow Creek. Hazardous substances are pervasive throughout the Silver Bow Creek ecosystem. The waters of Silver Bow Creek, the limited aquatic life able to survive in the Creek, and the floodplain and streambed of the Creek are contaminated. Natural processes, such as erosion, transport, and redeposition of contaminated materials, ensure that releases of hazardous substances are continuous.

Injuries to the Silver Bow Creek ecosystem from releases of hazardous substances include the following:

- 1) Surface water contains concentrations of hazardous substances that exceed criteria established for the protection of aquatic life and thresholds that have been demonstrated to cause injury to fish.
- 2) Streambed sediments contain significantly higher concentrations of hazardous substances than exist under baseline conditions and constitute a pathway to benthic macroinvertebrates and fish. For example, copper concentrations are nearly 5,000 times baseline concentrations; cadmium, lead, and zinc are more than 100 times baseline concentrations; and arsenic is roughly 80 times the baseline concentration.
- 3) The number of benthic macroinvertebrate taxa is significantly reduced relative to baseline conditions. For example, less than one mayfly or stonefly taxa, on average, is found in Silver Bow Creek compared to nine such taxa found under baseline conditions.

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- 4) Fish have been eliminated from Silver Bow Creek. In comparison, under baseline conditions, Silver Bow Creek would support, on average, over 250 trout per hectare.
- 5) 748 acres of Silver Bow Creek's floodplain contain phytotoxic concentrations of hazardous substances. Consequently, these areas are virtually devoid of vegetation and are incapable of supporting wildlife.
- 6) 1304 acres of Silver Bow Creek's floodplain (including the 748 acres that are virtually devoid of vegetation) contain tailings and contaminated soils that are a source of hazardous substances to Silver Bow Creek aquatic resources, including surface water, streambed sediments, and benthic macroinvertebrates.
- 7) Populations of otter, mink, and raccoons that rely on fish or benthic macroinvertebrates in their diets have been virtually eliminated from the Silver Bow Creek ecosystem.

For the purposes of this report it is useful to divide Silver Bow Creek into four reaches: 5.2 miles from the Colorado Tailings to the town of Nissler (Reach 1); 5.6 miles from Nissler to the upper end of Durant Canyon (Reach 2); 5 miles within Durant Canyon (Reach 3); and 6.8 miles from the lower end of Durant Canyon to the Warm Springs Ponds (Reach 4).

The extent of floodplain contamination in each of these reaches reflects the geomorphology of the Creek. Upstream of the canyon and downstream of the canyon, where the floodplain is relatively broad, contamination extends across 457 acres and 733 acres, respectively. In the canyon, where the floodplain is confined, contamination extends across 114 acres.

4.2 Sources of Hazardous Substances

Various waste sources contribute to injuries in the Silver Bow Creek ecosystem. Sources include those in the Butte area and Area One discussed in Chapter 3. Releases of hazardous substances from the Montana Pole and Treating Plant and the Rocker Timber and Framing Plant are discussed in Chapters 5 and 6, respectively.

Waste sources addressed in this chapter are of two types:

- 1) tailings and contaminated soils on the floodplain of Silver Bow Creek; and

2) streambed and streambank sediments within the channel of Silver Bow Creek.

Release mechanisms differ for aquatic resources and riparian resources. Mass wasting, bank erosion and slumping, and surface runoff over tailings release hazardous substances to surface water and bed sediments. In addition, at high water stage Silver Bow Creek carries increased quantities of contaminated suspended sediments from reaches upstream to those downstream. As high waters recede contaminated material is redeposited in bed, bank, and floodplain areas. For riparian resources, release mechanisms include geochemical oxidation/reduction and desorption processes in contaminated floodplain tailings and soils. These processes increase the bioavailability of hazardous substances to riparian vegetation.

An estimated 2,832,000 cubic yards of tailings and contaminated soils ranging in thickness from a few inches to as much as 6 feet overlie the original floodplain surface. Infiltration of precipitation through tailings has leached hazardous substances to underlying floodplain soils and groundwater. Approximately 1304 acres of floodplain have been contaminated by hazardous substances. Of this area, approximately 748 acres have been contaminated so severely that vegetation is virtually non-existent. These areas have no ability to support wildlife.

The bed of Silver Bow Creek is comprised of contaminated sediment and underlying contaminated alluvial material. Streambed contamination is variable, depending on channel form (i.e. riffle, pool, or run) and stream reach location. The thickness of contaminated material is estimated to range from several inches to 2.5 feet. The volume of contaminated material within the Silver Bow Creek streambed is estimated to range from 81,900 cubic yards to 321,500 cubic yards.

4.3 CERCLA Response Actions

The Remedial Investigation/Feasibility Study (RI/FS) for Silver Bow Creek is in progress. The RI/FS will evaluate remedial options for floodplain tailings, streambed sediments and surface water. Options will include removal of contaminated materials, with on-site or off-site disposal, and *in-situ* immobilization of hazardous substances. One option presently under evaluation is an *in-situ* immobilization process known as STARS (Streambank Tailings and Revegetation Study). STARS entails the addition of lime and other

calcium compounds to tailings and contaminated soils and revegetating the amended area with acid and/or metal tolerant plant species, primarily grasses. Lime neutralizes acid pH conditions in tailings and contaminated soils, which immobilizes hazardous substances and permits the reestablishment of vegetation. By these mechanisms STARS seeks to prevent hazardous substances from reaching surface water by runoff or groundwater by leaching.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that the following actions are likely to be implemented at Silver Bow Creek:

- 1) excavation of floodplain tailings and contaminated soils within 50 feet of Silver Bow Creek;
- 2) partial backfilling of excavated areas and revegetation, primarily with grasses and willows;
- 3) relocation of excavated materials on-site away from the stream channel;
- 4) treatment of unexcavated floodplain tailings and contaminated soils and relocated materials with STARS; and,
- 5) management of grazing to protect STARS-treated floodplain areas.

Floodplain excavation will occur mainly within 50 feet of Silver Bow Creek, where shallow groundwater often occurs, because shallow groundwater is believed to reduce the effectiveness of STARS. Excavation of floodplain materials within 50 feet of Silver Bow Creek would occur over 63 acres containing 174,800 cubic yards of tailings and contaminated soils (Reach 1); 68 acres containing 194,200 cubic yards (Reach 2); 61 acres containing 132,900 cubic yards (Reach 3); and 82 acres containing 144,200 cubic yards (Reach 4). In total, 274 acres containing 646,100 cubic yards of material will be excavated.

Excavated materials would be relocated on-site away from the stream channel. A few native grass and shrub species would be planted in excavated areas. The remaining 1030 acres of floodplain containing approximately 2,185,900 cubic yards of undisturbed material and 833,100 cubic yards of relocated excavated material will be treated by STARS.

4.4 Residual Injury

The remedy will not return the aquatic and riparian resources of Silver Bow Creek to baseline, nor is it intended to. After implementation of the remedy sources of hazardous substances will remain, causing injuries to aquatic and riparian resources.

Reliance on STARS, and the inherent limitations of this method, enables residual injury to riparian resources to occur. Hazardous substances will remain in floodplain tailings and soils at concentrations that will be phytotoxic to many native species. This, and STARS' dependence on acid and/or metals tolerant grass and shrub species for revegetation, will result in poor vegetative diversity and a continuing reduction in wildlife habitat and the number of viable wildlife species over the STARS treated area.

Residual injury to aquatic resources will also occur from extant contamination in 23 miles of unremediated stream channel (bed and banks) and in the STARS-treated floodplain. During storm events, snowmelt runoff, and periods of high and overbank flow, hazardous substances residing in these areas will be eroded and remobilized. When this occurs, surface water concentrations of hazardous substances will exceed baseline conditions, and will likely exceed aquatic life criteria. Surface water and bed sediments will remain contaminated and will continue to expose benthic macroinvertebrates and animals (fish, otter, mink, and raccoons) that consume benthic macroinvertebrates. Trout populations that may reestablish following the completion of response actions will be greatly reduced relative to a baseline condition. Finally, over time stream channel migration will intercept STARS-treated floodplain materials and remobilize hazardous substances, thereby causing additional contamination to streambed sediments and surface water.

An additional concern is the effectiveness of STARS in maintaining a permanent vegetative cover. At the present time the Natural Resource Damage Litigation Program (NRDLP) believes there is a risk that over time the neutralization capacity of lime-amended soils will be depleted, causing pH levels to decrease and vegetation to die. In such an event, large areas of revegetated floodplain would revert to the present devegetated condition. Besides the loss of wildlife habitat, hazardous substances would become more available to remobilization by surface runoff and overbank high flows. This would accelerate and exacerbate the contamination of streambed sediments and surface water, which will occur

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry, no matter how small, should be recorded to ensure the integrity of the financial data. This includes not only sales and purchases but also expenses and income. The document further states that regular audits are necessary to verify the accuracy of these records and to identify any discrepancies. It also mentions that the records should be kept for a sufficient period to allow for future reference and analysis.

The second part of the document focuses on the management of inventory. It describes the various methods used to track stock levels, such as periodic counts and perpetual inventory systems. The document highlights the importance of knowing the location and quantity of inventory at all times to avoid shortages and overstocking. It also discusses the role of inventory in determining the cost of goods sold and the value of the company's assets.

The third part of the document deals with the collection of accounts receivable. It outlines the steps involved in sending out invoices, following up on late payments, and managing the risk of non-payment. The document stresses the need for prompt action to maintain healthy cash flow and to minimize the impact of bad debts. It also provides some advice on how to structure payment terms to encourage timely payment.

The fourth part of the document covers the management of accounts payable. It discusses the importance of paying suppliers on time to maintain good relationships and to avoid penalties. It also mentions the need to negotiate favorable payment terms and to keep track of the due dates for all liabilities. The document further states that accurate records of accounts payable are essential for preparing the balance sheet and for managing the company's debt.

The fifth part of the document discusses the preparation of financial statements. It describes the various types of statements, such as the income statement, balance sheet, and cash flow statement, and explains how they are derived from the underlying data. The document emphasizes the importance of presenting the information in a clear and concise manner that is easy to understand for management and other stakeholders. It also mentions the need to comply with applicable accounting standards and regulations.

The sixth part of the document focuses on the management of fixed assets. It describes the various methods used to depreciate these assets and to calculate their book value. The document highlights the importance of knowing the useful life and salvage value of each asset to determine the appropriate depreciation rate. It also discusses the role of fixed assets in determining the company's net worth and its ability to generate cash flow.

The seventh part of the document deals with the management of taxes. It outlines the various types of taxes that the company is subject to, such as income tax, sales tax, and property tax. The document discusses the importance of staying up-to-date on tax laws and regulations and of consulting with a tax professional to ensure compliance. It also mentions the need to keep accurate records of all tax-related transactions and to file returns on time.

The eighth part of the document covers the management of the company's overall financial health. It discusses the various factors that can affect the company's financial performance, such as changes in market conditions, competition, and internal operations. The document emphasizes the importance of monitoring these factors closely and of taking proactive measures to address any potential risks. It also mentions the need to develop a comprehensive financial strategy that takes into account all aspects of the company's operations.

The ninth part of the document discusses the management of the company's cash flow. It describes the various sources of cash, such as sales, loans, and investments, and explains how they are used to fund the company's operations. The document highlights the importance of maintaining a positive cash flow to ensure the company's survival and growth. It also mentions the need to develop a cash flow forecast to anticipate future needs and to manage the company's liquidity.

The tenth part of the document covers the management of the company's risk. It discusses the various types of risks that the company is exposed to, such as market risk, credit risk, and operational risk. The document describes the various methods used to identify, measure, and manage these risks, such as diversification, hedging, and insurance. It emphasizes the importance of having a comprehensive risk management strategy in place to protect the company's assets and ensure its long-term success.

over time in any event, but at a slower rate.

4.5 Restoration Alternatives

4.5.1 Introduction

In Section 4.3, NRDLP anticipated that STARS would be a significant part of the remedy at Silver Bow Creek. Since a remedy that utilizes STARS will not result in the restoration of resources and services, alternatives are proposed that would conflict with remedy if STARS is implemented prior to the restoration action. However, as discussed in Section 1.2.2., restoration planning will be coordinated, to the maximum possible extent, with response action planning. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action. As part of this coordination, various agencies involved in response and restoration actions are engaged in ongoing discussions concerning STARS. Based on these discussions, this plan may be revised.

In addition to issues related to STARS, in designing alternatives it was necessary to take into account the widespread and severe nature of the contamination to this riparian ecosystem. To produce benefits to the affected resources and to control migration of hazardous substances to downstream resources, intensive actions such as physical removal of tailings and contaminated soils are required.

4.5.2 Alternative 4A

This alternative would restore aquatic and riparian resources by removing contaminated floodplain tailings and soils and excavating and reconstructing the Silver Bow Creek stream channel. The key elements of this alternative include:

- 1) excavating 1,030 acres of tailings and contaminated soils within the Silver Bow Creek floodplain;
- 2) excavating 22.6 miles of the Silver Bow Creek streamchannel;
- 3) disposal of excavated materials at the Anaconda and/or Opportunity Ponds;
- 4) partial backfilling of excavated floodplain areas with clean fill;
- 5) covering all excavated areas with six inches of growth media;
- 6) revegetating excavated areas with native grasses, shrubs, and trees;
- 7) partial backfilling and reconstructing the streamchannel of Silver Bow Creek;

- 8) management of grazing to allow vegetation to reestablish; and
- 9) natural recovery.

Under this alternative all floodplain tailings and contaminated soils beyond the 50-foot wide strip on each side of the Creek addressed by remedy would be excavated and disposed of off-site. Approximately 2,832,000 cubic yards of tailings and contaminated floodplain soils covering 1030 acres would be excavated. This volume includes the 646,100 cubic yards of material, that are to be excavated under remedy and relocated to other areas of the floodplain. The excavated floodplain would be partially backfilled (approximately 25%) with clean fill and growth media to create a floodplain contour that would support a mix of shrub/forest and agricultural (hay/pasture) habitats. An area equal to the extent of riparian wildlife habitat injury (748 acres) would be replanted with native species of grasses, shrubs and trees to reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. This 748 acres would include the 274 acres of floodplain within 50 feet of Silver Bow Creek excavated under remedy. The remaining 556 acres of contaminated floodplain would be replanted to stabilize excavated and backfilled areas. Grazing would be managed for a short period of time to facilitate revegetation.

The Silver Bow Creek streamchannel would also be excavated to remove contaminated streambed sediments, underlying contaminated alluvial material, and contaminated streambanks. Approximately 201,700 cubic yards of material (the midpoint of minimum and maximum volume estimates of contaminated bed materials) would be excavated. The streamchannel would be reconstructed to its approximate existing alignment. Streambanks would be reconstructed into a variety of slopes representative of baseline conditions and would be configured to provide riparian habitat for wildlife and cover for fish. The excavated streambed would be partially backfilled and reconfigured with channel bedforms (pools, bars, and riffles). During streamchannel excavation and reconstruction, the flow of Silver Bow Creek would be diverted into a temporary bypass channel or culvert.

Excavated floodplain and streamchannel materials would be disposed of at the Anaconda and/or Opportunity Ponds.

Notwithstanding the extensive removal actions contemplated by this alternative, residual contamination will persist due to the extent and severity of contamination in the

Silver Bow Creek ecosystem. Natural recovery will address this residual contamination. This alternative would restore aquatic and riparian resources and service flows to baseline in approximately 200 years.

Before Silver Bow Creek returns to baseline, substantial recovery will have occurred. Maturation of reestablished streamside and other floodplain vegetation, and recovery of viable benthic macroinvertebrate communities and salmonid fisheries will occur in about 30 years.

4.5.3 Alternative 4B

The focus of this alternative is to address injuries to aquatic resources and enhance near-stream riparian wildlife habitat. The key elements of this alternative include:

- 1) excavating 445 acres of tailings and contaminated soils within the Silver Bow Creek floodplain;
- 2) excavating 22.6 miles of the Silver Bow Creek streamchannel;
- 3) disposal of excavated materials at the Anaconda and/or Opportunity Ponds;
- 4) partial backfilling of excavated floodplain areas with clean fill;
- 5) covering excavated areas with six inches of growth media;
- 6) revegetating excavated areas with native grasses, shrubs, and trees;
- 7) partial backfilling and reconstructing the streamchannel of Silver Bow Creek;
- 8) management of grazing to allow vegetation to reestablish; and
- 9) natural recovery.

Unlike Alternative 4A, this alternative would not remove all tailings and contaminated soils from the floodplain. Rather, an additional 100 feet of floodplain beyond the area excavated under remedy would be excavated in Reaches 2 and 4, where tailings are widely dispersed across broad areas of the floodplain. This would create a remediated zone 300 feet wide. In Reaches 1 and 3, where tailings are more confined and generally do not extend beyond 150 feet into the floodplain, all tailings and contaminated soils remaining after remedy would be excavated. Approximately 1,043,100 cubic yards of tailings and contaminated floodplain soils covering 445 acres in the four reaches would be excavated. The excavated floodplain would be partially backfilled (approximately 25%) with clean fill and growth media to create a floodplain contour that would support a mix of shrub/forest and

agricultural (hay/pasture) habitats. On the 274 acres within 50 feet of Silver Bow Creek excavated under remedy and the 445 acres of floodplain excavated under this alternative, species of native grasses, shrubs, and trees would be replanted to densities and habitat types comparable to a baseline condition. This would restore 719 of 748 acres of injured riparian wildlife habitat.

All other elements of this alternative, including excavation of the Silver Bow Creek streamchannel and the disposal of excavated floodplain and streamchannel materials, would proceed as described in Alternative A.

Under this alternative restoration of resources and services to baseline would not occur for centuries. The added length of time to return to baseline for Alternative 4B as opposed to Alternative 4A is attributable to the fact that significantly more contamination is being left in-place under this alternative than Alternative 4A. After implementation of this alternative, 585 acres of floodplain containing 1,788,900 cubic yards of STARS-treated tailings and contaminated soils would remain. Most of this area and contamination would remain in Reach 4; approximately 100 acres containing 283,400 cubic yards of tailings and contaminated soils would remain in Reach 2. Natural processes will, over time, remove this contaminated material from the Silver Bow Creek ecosystem.

It is more difficult to assess the time frame for substantial recovery under this alternative because of the increased risk due to uncertainties associated with STARS. Clearly, the removal of an additional 100 feet of tailings and contaminated soil on each side of the Creek in Reaches 2 and 4, beyond the 50 foot removed under remedy, plus the complete removal of tailings and contaminated soils in Reaches 1 and 3, would improve the near-stream riparian environment and buffer Silver Bow Creek from remaining areas of contaminated floodplain. With successful near-stream revegetation and removal of 23 miles of stream channel contamination, a fishery and benthic macroinvertebrate community could substantially recover in approximately the same amount of time as under Alternative 4A. Riparian resources would recover largely to the same degree as under Alternative 4A. The additional 445 acres of floodplain excavated under this alternative, plus the 274 acres within 50 feet of Silver Bow Creek excavated under remedy, would enable restoration of 719 acres of 748 acres of injured riparian wildlife habitat.

It should be noted that recovery of aquatic resources under this alternative may well be transient. Given that STARS-treated floodplain areas will remain a source of hazardous substances to Silver Bow Creek due to natural processes of erosion (snowmelt, storm events, and overbank high-flow events) and stream channel migration, particularly in Reach 4 downstream of Durant Canyon, recontamination of the surface waters of Silver Bow Creek and the stream channel will occur over time. The timeframe over which such recontamination occurs, and the degree to which recontamination causes re-injury to aquatic resources, depends on the exact circumstances causing the recontamination. This cannot be predicted with certainty.

Moreover, if STARS is ineffective in maintaining a permanent vegetative cover, hazardous substances in floodplain deposits will be more susceptible to remobilization and migration to Silver Bow Creek and other parts of the floodplain from surface runoff or in the event of an overbank high-flow event or channel migration. Recontamination of excavated floodplain areas could threaten recovered riparian resources.

4.5.4 Alternative 4C

The focus of this alternative is restoration of aquatic and riparian resources in the 10.8-mile reach of Silver Bow Creek between the Colorado Tailings and Durant Canyon. The key elements of this alternative include:

- 1) excavating 327 acres of tailings and contaminated soils within the Silver Bow Creek floodplain above Durant Canyon;
- 2) excavating 10.8 miles of the Silver Bow Creek streamchannel;
- 3) disposal of excavated materials at the Anaconda and/or Opportunity Ponds;
- 4) partial backfilling of excavated floodplain areas with clean fill;
- 5) covering excavated areas with six inches of growth media;
- 6) revegetating excavated areas with native grasses, shrubs, and trees;
- 7) partial backfilling and reconstructing 10.8 miles of the Silver Bow Creek streamchannel;
- 8) management of grazing along 10.8 miles of Silver Bow Creek to allow vegetation to reestablish; and
- 9) natural recovery.

Under this alternative all sources of contamination within the floodplain and stream channel of Silver Bow Creek upstream of Durant Canyon (Reaches 1 and 2) remaining after remedy are removed. Within Durant Canyon and in the lower reach of Silver Bow Creek between Durant Canyon and Warm Springs Ponds (Reaches 3 and 4), no further actions beyond remedy are undertaken.

Excavation would involve 923,000 cubic yards of tailings and contaminated floodplain soils covering 327 acres. The excavated floodplain would be partially backfilled with clean fill and growth media to create a floodplain contour that would support a mix of shrub/forest and agricultural (hay/pasture) habitat types. The 327 acres of floodplain excavated under this alternative, together with the 131 acres within 50 feet of Silver Bow Creek excavated under remedy, would be revegetated with species of native grasses, shrubs, trees, and replanted to densities and habitat types comparable to a baseline condition. Grazing would be managed for a short period of time to facilitate revegetation.

10.8 miles of Silver Bow Creek would be excavated to remove contaminated streambed sediments, underlying alluvial material, and contaminated streambanks. Approximately 102,700 cubic yards of material (the midpoint of minimum and maximum volume estimates for Reaches 1 and 2) would be excavated from the streamchannel. The streamchannel (streambed and streambanks) would be reconstructed as described in Alternative 4A.

As under Alternatives 4A and 4B, excavated floodplain and streamchannel materials would be disposed of at the Anaconda and/or Opportunity Ponds.

With the removal of floodplain and stream channel contamination upstream of Durant Canyon, the time required to restore resources and services to baseline and to achieve substantial recovery in this reach of Silver Bow Creek would be virtually the same as the time required for restoration and substantial recovery under Alternative 4A.

Within and downstream of Durant Canyon, where no actions beyond remedy are undertaken, floodplain and stream channel contamination would remain. However, removing upstream sources of contamination that would otherwise migrate downstream will benefit aquatic resources in the downstream reaches. Leaving aside issues involving recontamination from STARS treated floodplain areas and the effectiveness of STARS in maintaining a

permanent vegetative cover, the amount of remaining contamination ensures that a substantial period of time, on the order of thousands of years, would be required before the lower reaches of Silver Bow Creek return to baseline.

Discussions of substantial recovery in this context are not particularly useful due to uncertainties associated with STARS. In the short term riparian habitat would improve relatively more than aquatic resources, which would be subject to continued contamination from surface runoff and stream channel contamination. However, to the degree riparian and aquatic resources recover, recovery may be temporary.

4.5.5 Alternative 4D

In this alternative no further action is taken at the site beyond the CERCLA response action. Under remedy, the entire contaminated Silver Bow Creek stream channel would be left in-place. A riparian zone 100 feet wide (50 feet on each bank) would be created by removal of tailings and contaminated soils and revegetating with a few grass and shrub species. Other native species would reestablish over time, assuming that recontamination of nearstream riparian resources is not significant. In the floodplain more than 50 feet from the Creek tailings and contaminated soils would be treated with STARS and revegetated primarily with grasses. Waste piles would be constructed, treated with STARS, and revegetated primarily with grasses.

In the near-term, residual streambed, streambank, and surface water contamination would prevent benthic macroinvertebrates, fish, and other animals from reestablishing to any great degree, if at all. Riparian vegetation would mature fairly quickly and provide some bank cover, stream shading, and wildlife habitat within a decade or two. However, riparian areas in the floodplain away from Silver Bow Creek would lack diversity and habitat layers and would provide only limited wildlife habitat.

The consequences of floodplain erosion and stream channel migration are difficult to predict with certainty. Storm and snowmelt runoff, overbank floods, and channel migration would continue transporting floodplain materials containing hazardous substances to Silver Bow Creek. In time, any fishery that may have reestablished would likely be eliminated. The period of time over which this could happen depends largely on the loading rate of contaminants to Silver Bow Creek. This could happen gradually with small but frequent

inputs from erosional processes or rather quickly during high-intensity flood events. Any widespread reversal of lime-amended soil conditions causing large areas of the floodplain to revert to its existing devegetated condition would accelerate the recontamination of Silver Bow Creek and reinjure the reestablished fishery. Thousands of years of natural processes would be required to removed hazardous substances from the Silver Bow Creek ecosystem.

4.6 Evaluation of Alternatives

4.6.1 Technical Feasibility

Alternatives 4A, 4B, 4C, and 4D are equivalent in terms of technical feasibility insofar as this determination relates only to technologies proposed to be implemented under the alternatives. As will be discussed below, the alternatives may not be equivalent in terms of technical feasibility insofar as this determination relates to aspects of remedy that are embedded in the alternatives.

With respect to the alternatives themselves; the alternatives equally employ well-known and accepted technologies and have a reasonable chance of successful completion in an acceptable period of time. The alternatives are all variations on a theme: removal of tailings and contaminated soils. Removal of tailings and contaminated soils from a floodplain is a straightforward proposition as evidenced by the fact that some removal of tailings and contaminated soils is anticipated to occur under remedy. Elimination of floodplain sources of contamination will produce immediate benefits to Silver Bow Creek. Excavation of streamchannel sediments and streambank and streambed reconstruction is similarly unremarkable.

With respect to what would actually occur at Silver Bow Creek under each of the alternatives, the technical feasibility of the alternatives' vary. Alternative 4A calls for the removal of all floodplain contamination. This alternative does not include a STARS component. Alternatives 4B and 4C utilize STARS to varying degrees. Under Alternative 4B, the STARS-treated floodplain located beyond 150 feet on either side of the Creek would be left in place. Under Alternative 4C, from the upstream end of Durant Canyon to Warm Springs Ponds, the STARS treated floodplain located beyond 50 feet on either side of the Creek would be left in place.

As discussed in §4.4, NRDLP has significant concerns related to STARS. Briefly,

these concerns are that in time the Creek will migrate into the STARS-treated floodplain area rendering the hazardous substances in the floodplain accessible to the Creek. In addition, overbank flow events will cause erosion and remobilization of hazardous substances. Finally, in what might be a relatively short period of time, the acid neutralization potential of the lime may become depleted causing those parts of the STARS-treated floodplain to revert to their present devegetated state. In short, at the present time NRDLP does not believe that STARS will accomplish its intended purposes.

Due to issues related to STARS, there is a significant difference in technical feasibility between Alternative 4A, which does not utilize the STARS remedy, and Alternatives 4B and 4C, which utilize the STARS remedy.

4.6.2 Cost-effectiveness

A distinction between Alternatives 4A, 4B, 4C and 4D cannot be made on cost-effectiveness grounds because the alternatives do not provide a similar level of benefits. The foregoing discussion on STARS is one example of how the alternatives differ in terms of their benefits. By utilizing STARS, Alternatives 4B and 4C produce a different level of benefits than Alternative 4A, which does not utilize STARS. Similarly, Alternative 4D, which contemplates no additional removal of floodplain contamination beyond that occurring under remedy produces a different level of benefits than the other alternatives, which all contemplate some amount of removal.

4.6.3 Results of Response Actions

Response actions anticipated to occur at this site will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

There are significant issues associated with the remedy at Silver Bow Creek. First, as just noted, are issues related to the efficacy of STARS. Second, and relatedly, are issues related to the integration of response actions and restoration actions.

The restoration alternatives were designed using one of two approaches. Alternative 4A was designed to restore Silver Bow Creek to a normal, functioning ecosystem. This alternative did not give credence to STARS as a viable technology. Alternatives 4B, 4C, and

4D, on the other hand, build on STARS (or, as in the case of Alternative 4D, rely on STARS in its entirety). Thus, these alternatives must be evaluated in the context of the State's overall concerns regarding STARS.

Alternative 4A would conflict with the STARS based remedy if remedy and restoration cannot be coordinated. Alternative 4B would also conflict with the STARS based remedy if remedy and restoration cannot be coordinated, although to a lesser extent than under Alternative 4A because some STARS-treated floodplain is being left in place. Finally, if coordination is not possible, Alternative 4C would conflict with the STARS based remedy to the same degree as Alternative 4A upstream of Durant Canyon, but would not conflict at all with the STARS based remedy from the Canyon to Warm Springs Ponds.

As discussed in the introduction to the plan, the operative assumption is that coordination between response authorities and restoration authorities will occur. Should such coordination prove impossible, this plan will be revised.

4.6.4 Potential for Additional Injury

There will be minor, short-term impacts from the implementation of the action alternatives. Since Alternative 4A is more intensive than the other alternatives, impacts, to the extent they occur, will be greater under this alternative. Impacts will be those customarily associated with construction activities. Particulate matter will be emitted and runoff to Silver Bow Creek will occur. These impacts will be mitigated using standard practices.

Other impacts associated with the action alternatives include the disturbance of what little floodplain vegetation exists. Other minor, short-term impacts are associated with streamchannel excavation. Streambed sediment removal and the temporary dewatering of the Creek will eliminate the depauperate macroinvertebrate community. Sediment removal will enable macroinvertebrates to recover within a few years after the completion of the action.

4.6.5 Natural Recovery and the Ability of the Resource to Recover

Recovery times for all the alternatives except Alternative 4A are bound up with STARS issues. Under Alternative 4A, the enormous volume of contamination in the Silver Bow Creek drainage, will prevent baseline from being reached for approximately 200 years.

However, the establishment of a healthy riparian corridor and the return of large numbers of trout to Silver Bow Creek will result in substantial recovery in about 30 years.

For the remaining alternatives, evaluation of estimates of recovery differ depending on whether restoration to baseline is used or substantial recovery is used. It is far easier to project restoration to baseline because restoration to baseline is a function of the amount of contamination left in the floodplain. And, this is so regardless of the efficacy of STARS. Thus, for example, it will take less time to reach baseline under Alternative 4B--centuries--than under Alternative 4D--thousands of years--because more contamination is removed under Alternative 4B than Alternative 4D.

With regard to substantial recovery under Alternatives 4B, 4C, and 4D the situation is murkier. As discussed earlier, it is impossible to predict with any level of certainty the exact circumstances and time of the recontamination of Silver Bow Creek. Under any of the alternatives that utilize STARS, however, the question is not if recontamination will occur, but when.

4.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Risks to human health and safety, to the extent such risks exist, will be minimized by compliance with all applicable laws and regulations governing workplace safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected. Since Alternative 4A is the most intensive it would presumably have the greatest degree of risk associated with it. Under this same reasoning Alternative 4D would pose the least amount of risk to human health and safety.

4.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

4.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

4.6.9 Other Relevant Factors

In the course of planning its expedited response action for LAO, the U.S. EPA encountered a degree of community opposition to the disposal of tailings at the Opportunity Ponds. All of the action alternatives call for disposal of tailings and contaminated soils at Opportunity and/or Anaconda Ponds. Decisions regarding disposal will be made during the preparation and implementation of a Restoration Plan.

4.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 4A--\$87.1 million; Alternative 4B--\$50.3 million; Alternative 4C--\$41.7 million; and Alternative 4D--\$1.9 million. Based on the following analysis, and informed by the State's knowledge of the resource, the State selects Alternative 4A.

Silver Bow Creek is, or could be, a valuable resource. It runs through one of Montana's largest cities, yet it is basically a dead system. Returning this resource to some level of function is vital. Moreover, and notwithstanding this plan's grave expressions of concerns over STARS, it is evident that U.S. EPA and MDHES share this sentiment.

STARS was the critical issue here; all other issues paled by comparison. NRDLP simply could not select a remedy which utilized STARS. At present, NRDLP does not believe STARS will work as intended. Furthermore, even if NRDLP was less certain of this, NRDLP would still be unwilling to accept the risk associated with STARS.

In the final analysis, the alternative's costs must be looked at alongside all of the relevant factors. An expenditure of \$80 million dollars to restore a resource that has been unavailable to the citizens of Montana for approximately 100 years and would remain unavailable for generations to come were restoration actions not undertaken is entirely justified.

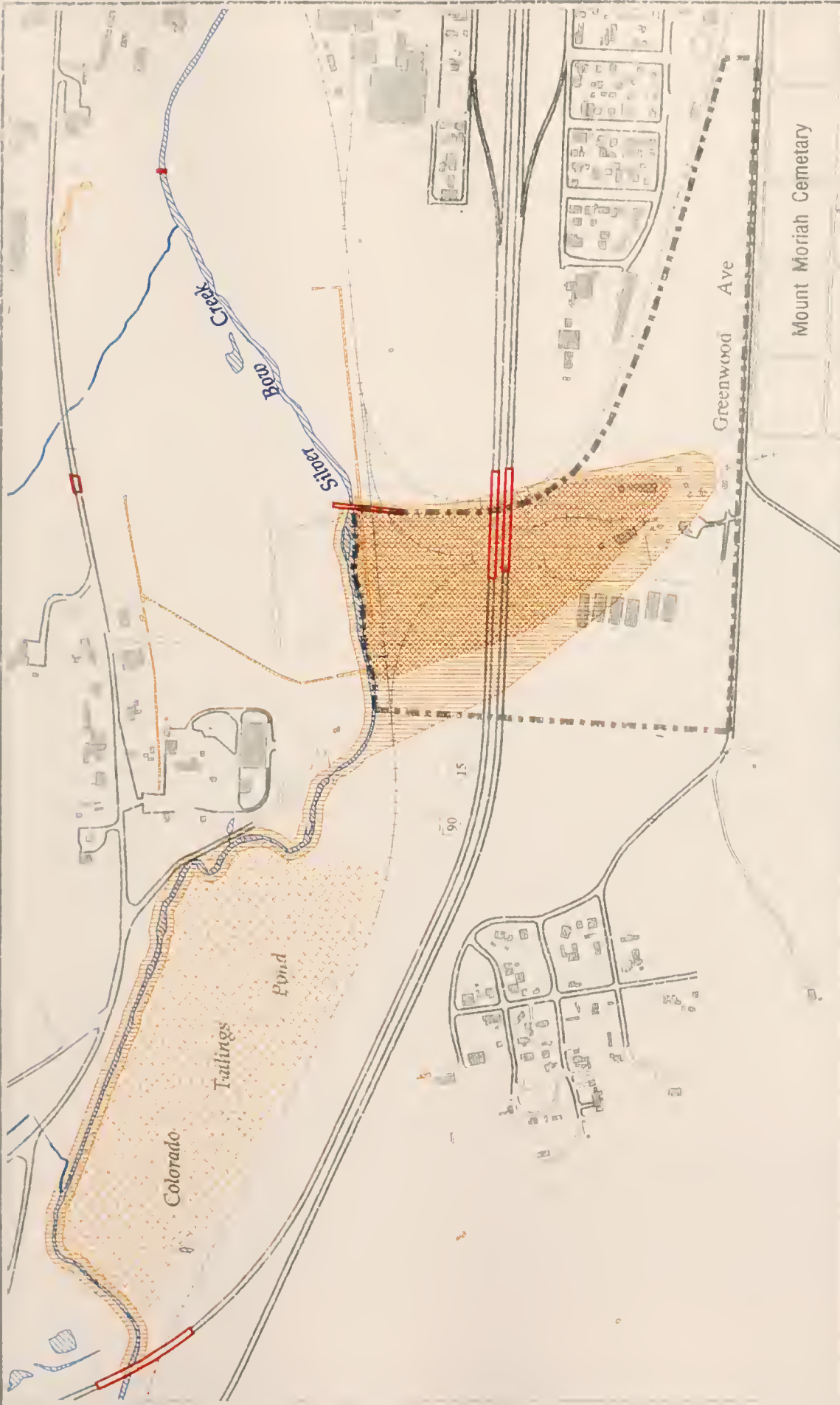


Figure 5-1. Montana Pole Site

5.0 MONTANA POLE GROUNDWATER AND SOIL RESOURCES

5.1 Description of Site and Injury

From 1946 to 1984, the Montana Pole and Treating Plant utilized pentachlorophenol (PCP) and diesel fuel to preserve wood products. The site is located in the southwest portion of Butte and is bounded on the north by Silver Bow Creek, on the east by a railroad right-of-way, on the south by Greenwood Ave, and on the west by the former location of the Colorado Smelter. An elevated portion of Interstate 15/90 cuts across the site in an east-west direction.

During the lifetime of the facility, hazardous substances--primarily in the form of PCP--were released to the environment. Based on the size of the groundwater contaminant plume, it is estimated that there are 1.1 million pounds of PCP at the site. Other contaminants released from the plant and detected on site include: polynuclear aromatic hydrocarbons (PAH), BTEX (benzene, toluene, ethylbenzene, and total xylenes), dioxins, and furans. Due to the threat to public health and the environment from these releases, in 1987 EPA placed Montana Pole on the National Priorities List.

Wood treating fluids containing hazardous substances were released directly to the ground surface over the period of plant operations. Subsequent transport of hazardous substances through the soil and to groundwater has resulted in widespread contamination throughout the site. The connection between site groundwater and Silver Bow Creek has resulted in hazardous substances (primarily PCP) being transported to the Creek.

As measured by exceedances of the maximum contaminant level of one part per billion for PCP, the areal extent of groundwater contamination is 44 acres, with a total volume of about 350 acre-feet. Approximately 239,000 cubic yards of soil is also contaminated by PCP.

5.2 Sources of Hazardous Substances

At Montana Pole soils and groundwater contaminate each other. Specifically, the hazardous substances in the contaminated groundwater plume are in a non-aqueous phase (oil product) and a dissolved phase. The non-aqueous phase floats on top of the groundwater and is up to three feet thick. When the groundwater level fluctuates, some portion of the floating

product adheres to the soils it contacts. Thus, the groundwater is continually recontaminating soils.

Upon contact with groundwater, either through water table fluctuations or capillary action, PCP in the soils will be transported to and dissolved in the groundwater. Unlike the non-aqueous phase, the dissolved phase is not confined to the groundwater surface but extends throughout the aquifer. The dissolved phase moves with the groundwater through the aquifer to Silver Bow Creek.

Contaminated soils also serve as a source for groundwater contamination due to infiltration of precipitation. Water moving through overlying contaminated soils transport PCP and other hazardous substances to groundwater.

5.3 CERCLA Response Actions

Response actions were undertaken as early as 1985 with the installation of two groundwater interception/oil recovery systems. The following year approximately 10,000 cubic yards of contaminated soil were excavated, bagged, and placed into storage in metal buildings on-site.

Additional response actions were initiated in late 1992, and included the construction of an 890-foot barrier wall to intercept LNAPL before it reaches Silver Bow Creek and the installation of ten recovery wells. Each well has two pumps. One pump collects floating product, the other pumps groundwater to a treatment facility constructed on-site. With the installation of this system, the system installed in 1985 was shut down.

A Record of Decision (ROD), which outlines the selected remedy, was issued by MDHES and EPA in September 1993. The components of the selected remedy are outlined below:

- 1) excavation of 198,000 cubic yards of contaminated soils;
- 2) treatment of excavated soils to cleanup levels of 34 ppm for PCP by above ground biological treatment;
- 3) backfilling 208,000 cubic yards of treated soils meeting cleanup levels into excavated areas;
- 4) revegetating the site;

- 5) soil flushing 41,000 cubic yards of contaminated soils underlying a berm supporting Interstate 15/90 and 3,000 cubic yards of contaminated soils underlying structures on site, such as the water treatment plant;
- 6) containment of contaminated groundwater and LNAPL using physical and/or hydraulic barriers (as determined during remedial design) in order to prevent the spread of contaminated groundwater and LNAPL and to limit releases of contamination to Silver Bow Creek;
- 7) treatment of extracted groundwater to cleanup levels by the existing treatment plant, and reinjection or discharge to Silver Bow Creek of the treated groundwater;
- 8) in-place biological treatment of contaminated groundwater, inaccessible contaminated soils areas, and contaminated soils not recovered by excavation; and
- 9) institutional controls to prevent any residential use of the site.

Under the remedy, soil excavation and treatment will address 198,000 cubic yards of soil and 10,000 cubic yards of soil stored on site. Soils will be treated until they reach the cleanup level of 34 ppm for PCP--a risk based cleanup level to protect public health for recreational and industrial uses--at which point the soils will be backfilled into the excavated area. 44,000 cubic yards of soil under the highway berm and site structures will not be excavated but will be treated by soil flushing and in-situ biological treatment.

The remedy establishes groundwater points of compliance at the waste management boundary, which will likely be the edge of the excavated area, and along the south bank of Silver Bow Creek. Pumping and treating contaminated groundwater seeks to ensure that groundwater clean-up levels are not exceeded at these points of compliance and that the plume of contamination does not migrate into uncontaminated areas or the Creek. The expectation is that over time and in response to cleanup efforts, the volumes and concentrations of contamination in the groundwater plume will be reduced to the point where natural processes will ensure that cleanup levels are maintained at the points of compliance. When the site is stabilized, albeit still contaminated, pumping and treating is to be

discontinued. It is estimated this will occur in approximately 30 years.

The remedy utilizes institutional controls to prevent the use of site groundwater. Institutional controls will also address the contamination remaining in soils after treatment.

5.4 Residual Injury

The selected remedy outlined in the ROD will protect public health by reducing the volume and toxicity of the contamination presently found at the Montana Pole site and preventing further releases from the site. However, the remedy will not restore natural resources to baseline conditions, nor is it intended to.

After the implementation of the remedy, soils and groundwater will remain contaminated above baseline conditions. Approximately 44,000 cubic yards of soil under the highway berm and site structures will not be excavated. Thus, floating product will remain under the highway and site structures. These soils will be treated in-place by soil flushing and biological treatment. But, these treatment methods are not expected to be nearly as effective in reducing contaminant levels as excavation and above-ground treatment are expected to be. It is estimated that 10% of the existing contamination will remain on-site. Considering the extent and degree of contamination at the site, substantial residual contamination will remain beneath site structures. Using the 1.1 million pounds of PCP estimate provided above, 110 thousand pounds of PCP will remain beneath site structures. By the processes described earlier, contaminants in these soils will be transported to groundwater.

Soils that are excavated, treated to 34 ppm, and backfilled will also remain contaminated. It is estimated that 16,000 pounds of PCP will remain in the backfilled soils. Because the excavation will extend below the water table and because the water table fluctuates, contaminants in the backfilled, treated soils will be transported from soils to groundwater. Contaminants in backfilled soil above the water table will also be transported to groundwater as precipitation infiltrates through the soil.

Although the remedy's pumping and treating and in-situ biological treatment program will reduce levels of contamination, it will not (and does not attempt to) restore groundwater to baseline conditions. Rather, the program reduces contamination and limits the spread of

the plume. Once the plume is contained within the site, pumping and treating will cease and residual contamination is to be addressed by natural processes. It is estimated that 350 acre-feet of groundwater will remain contaminated upon completion of the remedy.

5.5 Restoration Alternatives

5.5.1 Introduction

As discussed in Section 1.2.2., restoration planning will be coordinated, to the maximum possible extent, with response action planning. The Natural Resource Damage Litigation Program (NRDLP) will endeavor to implement restoration actions in conjunction with the response action. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action.

While remedy reduces and contains contamination, the remedy will leave contamination on-site in the form of soils under the highway berm and other site structures and backfilled soils at the 34 ppm cleanup level for PCP. To address these sources of contamination, an alternative is proposed that would conflict with the remedy if the remedy is implemented prior to the restoration action. As noted, it is NRDLP's intention that conflicts be avoided by coordinating with CERCLA response authorities. Accordingly, the alternatives are premised on this assumption.

5.5.2 Alternative 5A

This alternative seeks to restore resources and services to baseline in as short a time as possible. It does this by removing all accessible sources of contamination and by continuing pumping and treating to remove all contaminants and address residual on-site contamination. Its critical elements include:

- 1) excavation of contaminated soils under the highway berm;
- 2) off-site disposal of soils to be treated and soils excavated under the highway berm;
- 3) backfilling excavated areas with clean fill and highway berm replacement;
- 4) pumping and treating contaminated groundwater with in-place biological treatment; and
- 5) natural recovery.

Under this alternative, 208,000 cubic yards of contaminated soils to be treated and backfilled under remedy would, instead, be disposed of off-site. 41,000 cubic yards of contaminated soils beneath the highway berm would be excavated. This would require the removal of two highway support structures and the portion of the highway on top of the berm. It would also require the excavation and stockpiling of the berm to access the contaminated soils. This task would take approximately 2 months. Disposal of contaminated soils would occur off-site.

Soils and contamination not addressed under this alternative comprise approximately 3,000 cubic yards of soils under site structures. Under these structures floating product would remain, constituting a source of contamination. As noted, various treatment techniques employed by remedy will attempt to address this remaining product.

Pumping and treating is necessary to address on-site contaminated groundwater. Pumping and treating is part of the remedy but it is an equally critical component of this alternative. Groundwater would be pumped using the wells and/or recovery trenches employed during remedy. Groundwater would be treated to remove contaminants and then oxygenated prior to reinjection into the aquifer. The oxygenated water will enhance natural biological activity and help break down the organic compounds (PCP) in the soil and the groundwater.

Under this alternative restoration of resources and services to baseline would occur in several decades.

Due to the fact that nearly all sources of contamination are being addressed under this alternative, significant benefits would accrue to the resource relatively rapidly. Substantial recovery, whereby virtually all of the floating product at the site would be eliminated, would occur within a year after the completion of excavation.

5.5.3 Alternative 5B

This alternative removes a significant source of contamination at the site and relies, in large part, on the remedy's components. Its critical elements include:

- 1) excavation of contaminated soils under the highway berm;
- 2) land-treatment of soils excavated from under the highway berm and relocating

- the soils to the site-wide excavation;
- 3) backfilling excavated area with clean fill and highway berm replacement;
 - 4) pumping and treating contaminated groundwater with in-place biological treatment; and
 - 5) natural recovery.

By removing 41,000 cubic yards of contaminated soils under the highway, this alternative addresses a major source of contamination remaining on site after implementation of the remedy. Contaminated soils from underneath the highway berm would be land-treated to the PCP cleanup level of 34 ppm PCP and placed into the site-wide excavation along with the other 208,000 cubic yards. Contaminated soils from underneath the berm would not be put back into their original location because the berm and the highway have to be reconstructed immediately and cannot wait for a reduction in soil contaminant levels.

As in Alternative 5A, pumping and treating would be necessary to address contaminated groundwater.

Under this alternative, more contamination is being left on-site than in Alternative 5A. Contamination located in the backfilled, treated soil will migrate to groundwater. Pumping and treating and biological treatment would partially address this contamination. Residual contamination will also be depleted as a result of biological and chemical processes. It is estimated that restoration of resources and services to baseline would occur in approximately a century. Substantial recovery, would take the same length of time under this alternative as under Alternative 5A because removal of floating product under the highway will eliminate virtually all the product on site.

5.5.4 Alternative 5C

This alternative relies on pumping and treating, rather than removal. Its critical features include:

- 1) pumping and treating contaminated groundwater with in-place biological treatment; and
- 2) natural recovery.

Under this alternative, residual soil contamination would be addressed indirectly by

allowing contaminants to migrate to groundwater and then by treating the groundwater. With no removal of contaminated soils, this alternative ensures a longer period for restoration. It is estimated that restoration of resources and services to baseline would take a few centuries. Substantial recovery, whereby virtually all of the floating product at the site is eliminated, would occur in approximately 30 years as a result of the benefits from pumping and treating.

5.5.5 Alternative 5D

In this alternative no further action is taken at the site beyond the remedy.

Monitoring and oversight would occur to evaluate site conditions and the process of natural recovery. As described earlier, pumping and treating would cease pursuant to the remedy when the site was stabilized, which is estimated to occur in 30 years. Natural recovery would then be relied on to restore the site to baseline. As a result of ceasing pumping and treating, it will take considerably longer to reach baseline in this alternative than under the previous alternatives. It is estimated that restoration of resources and services to baseline would occur in three to five centuries. Substantial recovery would occur in the same length of time under this alternative as under Alternative 5C because elimination of virtually all floating product assuming no additional source removal is a function of pumping and treating, and it is anticipated that remedy will pump and treat for 30 years.

5.6 Evaluation of Alternatives

5.6.1 Technical Feasibility

The alternatives are equivalent in terms of technical feasibility. Alternative 5A is unremarkable in its proposal to dispose of contaminated soils off site and rely on pumping and treating. Alternative 5B does not rely on off-site disposal but, instead, land-treats contaminated soils excavated from under the highway. Land-treatment is utilized by remedy and, according to the Montana Pole ROD, is a treatment technology that has been "used in full scale application at other sites." ROD at p. 35. Alternative 5C relies entirely on pumping and treating, which is a technology commonly used to address PCP contamination. Alternative 5D is based on natural recovery.

5.6.2 Cost-effectiveness

A distinction between the alternatives cannot be made on cost-effectiveness grounds

because the alternatives provide different levels of benefits. The time frame for restoration to baseline varies widely between the alternatives. Under Alternative 5A baseline will be reached in several decades; under Alternative 5B baseline will be reached in approximately a century; under Alternative 5C baseline will be reached in a few centuries; and under Alternative 5D baseline will be reached in 300 to 500 years.

There are other differences between the alternatives as well. For example, as discussed more fully below, Alternative 5A would dispose of all contaminated soils off-site, rather than land-treating these soils as remedy plans to do. On the other hand, Alternative 5B builds on remedy while only minimally supplanting remedy, and Alternative 5C does not supplant any of remedy's aspects.

5.6.3 Results of Response Actions

As discussed, response actions at Montana Pole that have occurred or will occur pursuant to the ROD will not restore injured resources and will leave significant residual injury. If restoration actions are not implemented groundwater at the site will remain contaminated for three to five centuries. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

Under Alternative 5A, contaminated soils that are excavated by remedy will be disposed of off-site in a RCRA subtitle C disposal facility. The land-treatment of these soils presently contemplated by remedy would not occur were Alternative 5A to be selected. Under Alternative 5B, contaminated soils that are excavated from beneath the highway berm would be land-treated and disposed of in the site wide excavation along with the rest of the land-treated soils. Alternative 5C entails pumping and treating, which will simply pick-up when pumping and treating pursuant to remedy terminates.

Alternative 5C is essentially separate from remedy. Alternative 5B requires coordination over remedy's plans for soil flushing under the highway berm and the alternative's proposal to excavate these soils and then dispose of them on-site. Alternative 5A will require additional coordination over issues related to the disposal of the contaminated soils remedy excavates in an off-site disposal facility.

As discussed in the introduction to this plan, the operative assumption is that

coordination between response authorities and restoration authorities will occur. Should it become evident that it will be impossible to coordinate either Alternative 5A or 5B with response actions, this plan will be revised.

5.6.4 Potential for Additional Injury

The implementation of these alternatives will result, to slightly varying degrees, in minor environmental harm. Alternative 5A poses the greatest potential risk of additional environmental harm because this alternative's contemplates disposal of PCP contaminated wastes in a off-site facility. This facility would meet applicable regulatory requirements. Still, there would exist the risk of groundwater contamination from the facility. In addition, the facility will be a new facility. Thus, there would be the typical environmental impacts associated with constructing such a facility. Finally, the facility would require that land be dedicated and disturbed.

There will also be environmental impacts related to the disposal of treatment plant wastes under Alternative 5A, as with all the alternatives. In fact, under Alternative 5A these impacts would be of less significance than the other alternatives because the treatment plant would need to operate for a shorter period of time under this alternative than the others. Impacts associated with the disposal of treatment plant sludges include air pollution caused by the transport and incineration of the sludges and the risk of environmental contamination from a spill or accident in route.

Alternative 5A also calls, as does Alternative 5B, for the excavation of contaminated soils under the highway berm. Minor environmental impacts, of a kind typically associated with construction, would result from this activity. These impacts--the release of particulate matter and runoff into surface water from the site, for example--would be mitigated to the fullest possible extent through the use of standard construction practices.

Excavation under the highway berm would also likely increase air pollution to a minor degree due to the need to detour traffic off the highway.

As noted, the potential for environmental impacts is less under Alternative 5B than Alternative 5A because Alternative 5B does not contain all of the elements contained in Alternative 5A. Similarly, Alternative 5C poses less of a risk than Alternative 5B.

Other than the long-term contamination of groundwater sanctioned by Alternative 5D, this alternative poses no risks to the environment. Under this alternative, the plume of contamination is contained within the site.

5.6.5 Natural Recovery and the Ability of the Resource to Recover

Under Alternative 5D, natural recovery will restore resources and services to baseline in 300 to 500 years. Substantial recovery of the resource, which at this site is defined as the time that virtually all of the floating oil product will be eliminated, will occur in approximately 30 years.

Under Alternative 5C, which begins to pump and treat site groundwater when remedy leaves off in 30 years, baseline will not be reached for a few centuries. With no additional source removal, the rate of substantial recovery is tied to pumping and treating. Thus, substantial recovery under Alternative 5C, is projected to occur in the same time frame as under Alternative 5D--30 years.

The removal of the large volume of PCP under the highway berm under Alternative 5B will substantially decrease the time to restoration compared to the two alternatives that do not propose any source removal. Under this alternative, baseline will be achieved in approximately a century. Substantial recovery would occur within one year since excavation of soils under the highway berm would remove virtually all of the floating product on the site.

Alternative 5A would reduce the time to restoration and substantial recovery rates still further. Under this alternative, baseline would be achieved in 30 years. Substantial recovery would take the same length of time here as under Alternative 5B since this alternative would also excavate contaminated soils beneath the highway berm.

5.6.6 Human Health and Safety

Alternative 5A probably presents the greatest risk to human health and safety of any of the alternatives, although the risk is not especially significant. Under this alternative it will be necessary to handle a substantial volume of highly contaminated soil in order to dispose of the soil at a facility. Although, all workplace safety and hazardous materials

handling requirements will be complied with, the health risks to the workers associated from this action cannot be completely eliminated.

Alternative 5A also includes removal of the highway berm to access contaminated soils, an element shared with Alternative 5B. This poses two concerns. First, worker exposure to hazardous substances during excavation is a possibility. Second, it will be necessary to detour traffic off the highway while this work is proceeding--projected to occur for two months. While traffic will be routed off the highway and the detour will be designed in as safe a manner as possible, such an action will inevitably present risks to the traveling public.

5.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

5.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

5.6.9 Other Relevant Factors

No other relevant factors have been identified.

5.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 5A--\$25.4 million; Alternative 5B--\$8 million; Alternative 5C--\$2 million; and Alternative 5D--\$.5 million. Based on the following analysis, and informed by the State of Montana's knowledge of the resource, the State selects Alternative 5B.

Several issues were critical in the State's selection of Alternative 5B. First, it was not deemed acceptable to allow groundwater resources to remain contaminated and be unavailable for use by the people of Montana for 300 to 500 years when actions could be taken at relatively low cost that would significantly lessen this period. It was for this reason the Alternative 5D was not acceptable.

Alternative 5C--pumping and treating--would not have significantly shortened the time

frame for restoration over Alternative 5D. Thus, if the State's choice had been between Alternative 5C and 5D, the State would have been constrained to choose Alternative 5D because of the lack of any real difference between the two. The length of time the treatment plant would have to operate was also a factor militating against the selection of Alternative 5C.

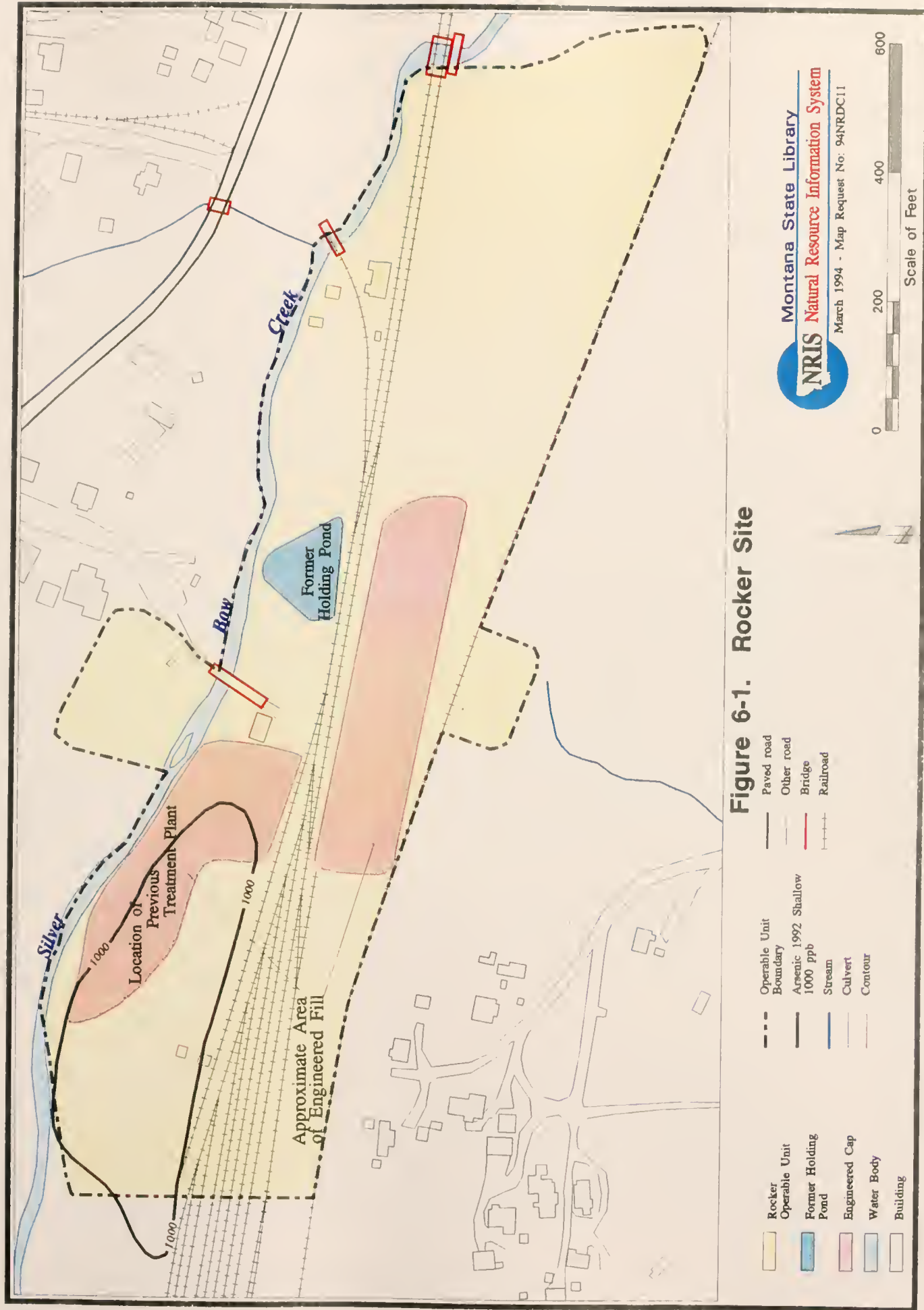
Alternatives 5B and 5A do produce significant gains to the resource. Under Alternative 5B, all of the floating product would be eliminated and most of the remaining contamination would be addressed. Alternative 5A addresses virtually all existing contamination. The difference between these two alternatives in terms of time to baseline is meaningful but not dispositive. Alternative 5A would reach baseline in 30 years, Alternative 5B would reach baseline in approximately a century. If this was the only consideration, the choice would likely have been Alternative 5A.

Alternative 5B was chosen over Alternative 5A for several reasons. First, both alternatives equally produce substantial recovery. Elimination of floating product at the site will greatly reduce concentrations of PCP in groundwater and will facilitate restoration. While it cannot be determined with any degree of precision, under Alternative 5B drinking water standards might be achieved in less than a century.

Second, Alternative 5B allows remedy's on-site treatment to go forward, while Alternative 5A does not. The preference for on-site treatment was a significant factor in the selection of remedy. On the other hand, Alternative 5A would require the construction of new disposal facility with its attendant environmental impacts.

Third, Alternative 5B is relatively inexpensive, given the degree of injury at this site and the relative benefits produced from implementing the alternative. Alternative 5A is three times more expensive than Alternative 5B, and could not be justified notwithstanding its short time frame for restoration.

Lastly, no other factors were deemed significant. Any risks associated with detouring traffic off the highway were acceptable. Environmental impacts were minor. Workplace safety and worker exposure to hazardous substances could be addressed by standard practices.



6.0 ROCKER GROUNDWATER AND SOIL RESOURCES

6.1 Description of Site and Injury

The site of the former Rocker Timber Framing and Treating Plant is adjacent to Silver Bow Creek approximately 7 miles west of Butte. The plant milled and treated timbers for the mining industry utilizing a process that required the application of dissolved arsenic and creosote. Releases of hazardous substances have resulted in soil and groundwater contamination. The site is a unit of the Silver Bow Creek/Butte Addition NPL site.

Organic compounds, metals, and metalloids released from wood treatment processes have been transported through soils to the water table and have contaminated the groundwater system underlying and adjacent to the site. Contaminants include arsenic, cadmium, copper, lead, zinc, iron, manganese, sulfate, and polynuclear aromatic hydrocarbons (PAH).

As delineated by exceedances of drinking water standards for various contaminants, there are approximately 191 acre-feet of contaminated groundwater. The areal extent of contamination is about 26 acres. Arsenic, which is the contaminant of most concern at Rocker, is present in concentrations exceeding drinking water standards in approximately 83-acre feet of groundwater. The arsenic plume is approximately 10 acres in areal extent.

The contaminant plumes extend to the west and below Silver Bow Creek and in a few areas extend approximately 50 feet below the land surface. Contamination is more severe in the shallow portions of the groundwater system. Contaminated groundwater may discharge to Silver Bow Creek.

Significant soil contamination exists at Rocker. Although contamination is present throughout the site, it is most severe in the northern part of the site, in the vicinity of the former treatment plant.

6.2 Sources of Hazardous Substances

At Rocker soils and groundwater contaminate each other. Contaminants in groundwater adhere to aquifer materials. In turn, contaminated soils are a source of contamination to groundwater. Infiltrating precipitation leaches contaminants from soils in the unsaturated zone to groundwater. In addition, upgradient groundwater moving through contaminated site soils is exposed to hazardous substances. Accordingly, soil contamination

perpetuates the contamination of groundwater and the migration of hazardous substances at the site.

There are approximately 30,000 cubic yards of soil at Rocker with arsenic concentrations at 500 ppm or greater. This soil is severely contaminated and appears to constitute a significant percentage of the soil contamination at the site. About half of the 30,000 cubic yards is located above the water table, the remainder is generally located in the uppermost zone of the water table.

Another source of contamination are those soils and aquifer materials associated with the most highly contaminated plume of groundwater at the site. This plume of contamination, represented by the 1,000 ppb arsenic isopleth, extends over approximately three acres. Soils and aquifer materials associated with this plume are likely to be highly contaminated relative to other site soils and aquifer materials.

6.3 CERCLA Response Actions

In 1989, in order to address an immediate threat posed by materials with arsenic concentrations greater than 10,000 ppm, approximately 1,021 cubic yards of arsenic-contaminated soil and wood chips were removed from the site. After removal of the materials, 12 inches of clean fill (8,800 cubic yards) were placed over a four-acre area.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that the following actions will likely be implemented at Rocker:

- 1) excavation of all soils above the water table with arsenic concentrations of 1,000 ppm or above;
- 2) backfilling excavated areas with clean fill and revegetating; and
- 3) institutional controls to prohibit the construction of wells in or near the area of contamination.

The arsenic cleanup standard for soils, 1,000 ppm, seeks to ensure that recreational visitors to the site are not subject to an unacceptable health risk. Soils with arsenic concentrations exceeding the cleanup standard are found primarily in the former treatment plant area. It is estimated that 15,000 cubic yards of soils exceed the cleanup level.

Disposal and/or treatment of the excavated soils will occur off-site.

6.4 Residual Injury

The estimated remedy will not restore resources to baseline conditions, nor is it intended to. As mentioned above, the remedy is based on an acceptable level of risk for those individuals who recreate on the site. Consequently, significant residual injury will remain.

Specifically, soils remaining at the site will contain concentrations of hazardous substances well above baseline conditions. Although contaminated soils above the water table with arsenic concentrations at or exceeding 1,000 ppm will be removed under remedy, contaminated soils above and below the water table with arsenic concentrations below 1,000 ppm and severely contaminated soils below the water table with arsenic concentrations above 1,000 ppm will remain on site after implementation of the remedy. As discussed, the residual level of contamination will limit uses of the site for the foreseeable future.

Since soils serve as a source of groundwater contamination, groundwater will remain injured after implementation of the remedy; after remedy there will be approximately the same amount of contaminated groundwater as there is presently.

6.5 Restoration Alternatives

6.5.1 Alternative 6A

In this alternative soils with arsenic concentrations exceeding 500 ppm would be removed. The key elements of this alternative are:

- 2) removing contaminated soils with arsenic concentrations at or above 500 ppm;
- 3) disposing of excavated soils off site;
- 4) backfilling excavated areas;
- 5) pumping and treating; and
- 6) natural recovery.

Under this alternative 15,000 cubic yards of soil with arsenic concentrations exceeding 500 ppm would be removed. Most of the soils to be removed are located below the water table. Pumping and treating groundwater within the area of the 1,000 ppb arsenic isopleth would remove a source of groundwater contamination and would address residual groundwater contamination. Treatment of metals, arsenic, and organics would occur in

sequence since all of these contaminants exist on the site. Twenty wells would be installed at approximately 100 foot intervals overlying the 1,000 ppb contour of the arsenic plume.

In this alternative, the most severely contaminated sources are removed. Pumping and treating, in conjunction with natural recovery, would address residual levels of groundwater contamination. Restoration of resources and services to baseline under this alternative would occur in approximately 100 years. Substantial recovery, whereby most, if not all, of the site would meet drinking water standards, is estimated to occur in approximately 30 years.

6.5.2 Alternative 6B

This alternative focusses on removal of the most severely contaminated soils and does not employ pumping and treating contaminated groundwater. The key elements of this alternative are:

- 1) removing contaminated soils with arsenic concentrations at or above 500 ppm;
- 2) disposing of excavated soils off site;
- 3) backfilling excavated areas; and
- 5) natural recovery.

Like Alternative 6A, under this alternative 15,000 cubic yards of severely contaminated soils would be removed. Pumping and treating to address residual contamination as hazardous substances mobilize from soils to groundwater and back will not occur.

Removal of source materials and the resultant dilution of the arsenic plume will substantially shorten the time that contaminated groundwater will discharge to Silver Bow Creek, that arsenic will migrate to, underneath, and beyond Silver Bow Creek, and that groundwater at the site will exceed drinking water standards.

Due to the fact that this alternative does not include pumping and treating, restoration time will be lengthened over the time estimated to return to baseline conditions under Alternative 6A. It is estimated that restoration of resources and services to baseline would occur in approximately 200 years. Similarly, substantial recovery to drinking water standards over all or most of the site will also be extended over the time for substantial recovery in Alternative 6A. Substantial recovery would occur in approximately 100 years.

6.5.3 Alternative 6C

In this alternative, no further action is taken at the site beyond the CERCLA response action. Monitoring and oversight would occur to evaluate site conditions and the process of natural recovery. It is estimated that restoration of resources and services and substantial recovery would occur in several centuries.

6.6 Evaluation of Alternatives

6.6.1 Technical Feasibility

Alternatives 6A, 6B, and 6C are equivalent in terms of technical feasibility. Alternative 6C, which calls for monitoring and natural recovery, is technically feasible. With respect to the other two alternatives, both alternatives equally employ well-known and accepted technologies and both have reasonable chance of successful completion in an acceptable period of time.

Alternatives 6A and 6B entail the removal of contaminated soil, which is also projected to occur under remedy. Pumping and treating, which is an element of Alternative 6A, is similarly unremarkable.

6.6.2 Cost-effectiveness

A distinction between Alternatives 6A, 6B, and 6C cannot be made on cost-effectiveness grounds because the alternatives do not provide a similar level of benefits. For example, the time to restoration and to substantial recovery will be different under each alternative. Another difference between the alternatives is that under Alternative 6A pumping and treating would be required, whereas under the other alternatives it would not.

6.6.3 Results of Response Actions

As discussed, the response actions that have occurred or are anticipated to occur at Rocker will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

Under both Alternative 6A and Alternative 6B it will be necessary to coordinate the excavation of contaminated soils proposed by the alternatives with the anticipated removal of contaminated soils under remedy. The alternatives assume such coordination will occur and

are costed out accordingly. Should coordination prove impossible this plan will need to be revised.

6.6.4 Potential for Additional Injury

There will be minor, short-term impacts from the implementation of the action alternatives. Impacts will be those customarily associated with construction activities. Particulate matter will be emitted and runoff to Silver Bow Creek will occur. These impacts will be mitigated using standard practices.

Alternatives 6A and 6B both require that contaminated soils be disposed of off-site. There will be minor environmental impacts associated with such disposal. Additional minor impacts will arise from the need to pump and treat under Alternative 6A. This will also necessitate shipping the wastes to a disposal facility.

6.6.5 Natural Recovery and the Ability of the Resource to Recover

Under Alternative 6A, restoration to baseline would occur in approximately a century; substantial recovery, whereby most, if not all, of the site is returned to drinking water standards would occur in 30 years. Under Alternative 6B, restoration to baseline would occur in approximately 200 years; substantial recovery would occur in approximately 100 years. Under Alternative 6C, restoration to baseline and substantial recovery would occur in several centuries.

6.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Since Alternative 6C entails no excavation or construction, this alternative would avoid any risks inherent in the undertaking of such activities. These risks, to the extent they exist under Alternatives 6A and 6B, will be minimized by compliance with all applicable laws and regulations governing workplace safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected.

6.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

6.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

6.6.9 Other Relevant Factors

No other relevant factors have been identified.

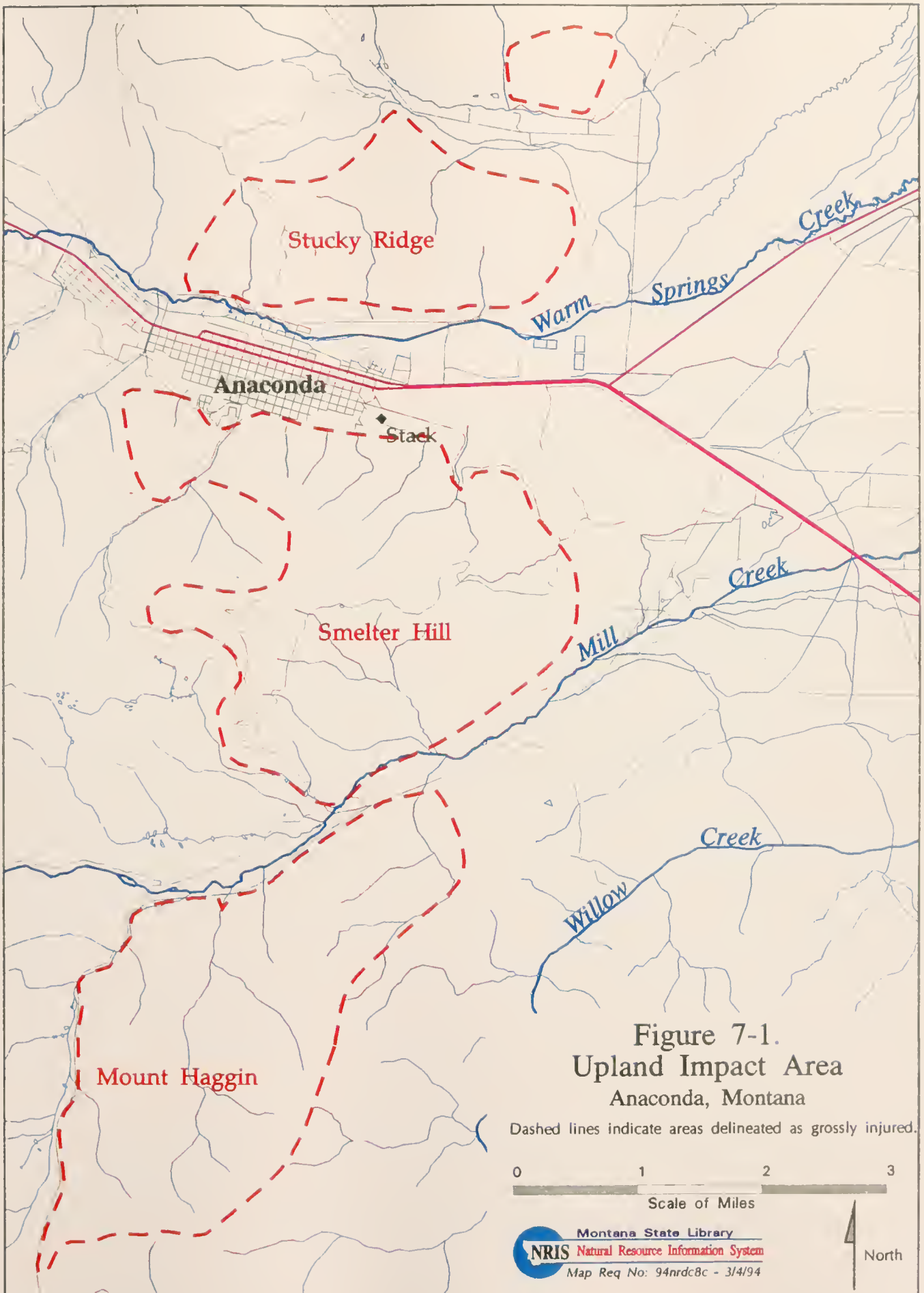
6.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 6A--\$8.4 million; Alternative 6B--\$1.9 million; and Alternative 6C--\$.6 million. Based on the following analysis and the State's knowledge of the resource, the State selects Alternative 6B.

The selection of Alternative 6B was based on three grounds. First, it was deemed advisable to accelerate the time to restoration. The Rocker area has become a vital part of the Interstate 90 commercial/transportation corridor due to its proximity to the city of Butte, the I-15 interchange, and the Port of Montana. The area is likely to grow in the future and will require additional water supplies. Even if this was not the case, however, several centuries to restore resources is simply too long when human intervention can accelerate the process.

Second, this is a relatively small site. Notwithstanding the above, the State could not justify selecting the most intensive alternative to produce gains to the resource that while meaningful, were not determinative.

Third, Alternative 5B achieves quite a lot with the expenditure of relatively little. By contrast, Alternative 5A is four times more expensive, and would not produce significant gains to the resource over Alternative 6B.



7.0 SMEILTER HILL AREA UPLAND RESOURCES

7.1 Description of Site and Injury

The Smelter Hill area upland habitat resource includes areas on Smelter Hill, Stucky Ridge, and Mount Haggin. The region has been injured due to releases of hazardous substances from mineral-processing activities. Enormous volumes of hazardous substances were continually released into the air by these operations and subsequently deposited onto the land.

The primary source of hazardous substances to upland resources were emissions from the Washoe (or Anaconda) smelter. Emissions from the Washoe smelter stack resulted in the deposition of hazardous substances across hundreds of square miles of surface soils surrounding and downwind from the stack. This has resulted in injury to soils, vegetation, wildlife habitat, and wildlife.

The injury determination for upland resources delineated those areas displaying gross (visible) injury attributable to the deposition of hazardous substances that were released as primary smelter emissions and/or secondary fugitive dust emissions. Grossly injured resource areas are defined as those areas which exhibit the following:

- 1) Complete or virtual elimination of indigenous major plant associations.
- 2) Little or no regeneration of indigenous major plant associations.
- 3) Extensive topsoil exposure and erosion due to vegetation loss.

Upland areas which meet the grossly injured criteria extend across approximately 17.8 square miles (11,366 acres) of land. The grossly injured area encompasses the eastern portion of Stucky Ridge and the hills on the north side of Lost Creek (2,409 acres), areas to the west and south of Smelter Hill (4,653 acres), and portions of Mount Haggin east of the Mill Creek Highway (4,304 acres). Elevations in the grossly injured area range from 5,300 feet at Lost Creek to over 7,000 feet on Mount Haggin. Out of the 11,366 acres that are grossly injured, 2,200 acres, or approximately 20% of the total, are located on slopes greater than 40%. Topsoil loss is associated with much of this area.

Soils in the grossly injured area have elevated concentrations of hazardous substances including arsenic, cadmium, copper, lead, and zinc. Laboratory tests have confirmed that these soils are phytotoxic, which is consistent with visual observation. Metal concentrations

are highest in the upper two inches of soil. Elevated metal concentrations on the soil surface prevent seed germination, which explains the lack of natural recovery in the area. Absent human intervention, concentrations will not be reduced sufficiently to allow for revegetation in a reasonable time frame.

In the injured area there has been a shift in plant community types from predominantly forests with open grassland to predominantly sparse grassland or bare ground. Absent hazardous substances in the soil, Smelter Hill and Mount Haggin would have vegetative cover consisting of approximately 70% forest and approximately 30% grassland; Stucky Ridge would have vegetative cover consisting of 30% forest and 70% grassland. Of the total 11,366 acres that exhibit gross injury, 6,993 acres (62%) would have been primarily forest land and 4,373 acres (38%) would have been primarily grassland.

The elimination of upland vegetation communities in the grossly injured area has resulted in a severe reduction in the quantity and quality of wildlife habitat. Wildlife such as birds of prey, woodpeckers, songbirds, squirrels, porcupine, and marten have suffered local extinction in the impacted areas. Many other species, including black bear and elk, are likely to have suffered population reductions.

7.2 Sources of Hazardous Substances

As noted above, the primary source of hazardous substances released to upland resources were emissions from the Washoe smelter stack. Mining and mineral-processing wastes disposed of directly on land surfaces in the Anaconda area are also sources of hazardous substances. Aerial deposition has resulted in widespread soil contamination. These contaminated soils are sources of on-going releases of hazardous substances through transport by the wind and redeposition onto the land surface and through surface runoff into water resources.

7.3 CERCLA Response Actions

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that remedial actions in the grossly injured area will entail grass and shrub reestablishment and berm construction for erosion control across 200-400 acres of Smelter Hill and Stucky Ridge. The principal focus

of remedial actions will be at location of the former smelter complex. Metal contamination can extend to depths of 4 feet in this area. Accordingly, extensive land disturbance will be required in order to reestablish vegetation.

7.4 Residual Injury

The residual injury to upland resources will essentially equal the current condition of the resource. Hazardous substance concentrations will remain elevated in surface soils resulting in continuing phytotoxicity. Thus, upland soils, vegetation, wildlife habitat, and wildlife will remain injured in the 17.7 square miles around Smelter Hill.

7.5 Restoration Alternatives

7.5.1 Introduction

Excluding an alternative that relies entirely on natural recovery, four restoration alternatives have been developed to address the residual injuries to upland resources in the Smelter Hill, Stucky Ridge, and Mount Haggin areas. All the alternatives focus on eliminating erosion across the injured area and revegetation of the injured area to provide cover and reestablish the vegetation complexity necessary to support viable populations of wildlife species typical of Montana upland habitat in this area. Each of the four alternatives will, to a greater or lesser extent, create improved conditions for wildlife within a reasonable period of time.

Revegetative success will depend on a number of factors. First, active mixing or turning of the contaminated land surface will be required to expose uncontaminated soils and reduce metal concentrations. Second, land disturbance and revegetation must occur over a large enough area to establish a vegetative community capable of moderating the microclimate and providing organic matter and seeds to the surrounding area. Third, soils must be stabilized and a build-up of soil structure promoted.

Distinctions between alternatives are superficially straightforward, relying, as they do, on variations in the percentage of the total injured area to be addressed. However, the specific actions to be undertaken under each alternative are somewhat more complicated. Actions must be targeted to particular site characteristics. Three basic types of conditions were identified as occurring in the grossly injured area that will require different treatments. These are: 1) areas with a slope of 40% or greater; 2) areas of deciduous shrub vegetation;

and 3) the remaining injured area comprised of grassland and bare ground.

A breakdown, by injured area, of these site conditions is as follows:

Stucky Ridge: (2,409 acres)

40% or greater slope--120 acres (5%)

deciduous shrub--145 acres (6%)

remainder--2,144 acres (89%)

Smelter Hill: (4,653 acres)

40% or greater slope--745 acres (16%)

deciduous shrub--651 acres (14%)

remainder--3,257 acres (70%)

Mount Haggin: (4,304 acres)

40% or greater slope--1,377 acres (32%)

deciduous shrub--818 acres (19%)

remainder--2,109 acres (49%)

As noted, treatments will vary depending on site specific conditions. In areas with steep slopes, i.e. greater than 40 degrees, it will be difficult to reestablish vegetation because these areas tend to be severely eroded and because earth moving equipment cannot be used. Nonetheless, revegetation in these areas is important because if left devegetated erosion will continue significantly increasing the length of recovery, and because ongoing erosion presents a threat to revegetative efforts in areas downslope.

In steep areas hand planting of trees and shrubs will be undertaken and grasses will be seeded. Revegetation will take into account ecological considerations. Thus, appropriate tree and shrub species will be utilized depending on such factors as aspect and elevation. In addition, vegetative islands will be created to provide a seed source and promote recovery of the surrounding area.

In deciduous shrub areas (mainly Aspen stands) there is limited diversity of species and frequently a complete lack of understory. To reestablish diversity necessary for viable wildlife habitat, native species will be reintroduced. Grass will be seeded and interspersed trees and shrubs will be hand planted at a rate per acre sufficient to reestablish diversity.

The specific species of grasses, trees, and shrubs to be planted will be based on ecological

considerations.

The remainder of the grossly injured area is characterized as grassland or bare ground. While areas delineated as grassland have some vegetative cover, the vegetation tends to be of very poor quality, consisting largely of noxious weeds. In fact, within the areas characterized as grassland, only 36 percent of the ground cover is live vegetation; most of the grassland area consists of bare ground or a shallow layer of litter (dead vegetation) overlying bare ground. Despite the overall poor quality of areas characterized as grasslands, some grassland areas--particularly on Mount Haggin--will require less intensive treatment than other areas.

Restoration actions will reestablish grasslands and forests across the injured area so as to reflect the baseline proportion of these ecotypes. As a first step, it will likely be necessary to establish grasses and forbs before planting trees and shrubs in order to stabilize the area to be revegetated and introduce organic matter.

To reestablish grasslands, small furrow-like impressions will be made in the acidic, metals-rich soil to allow for moisture retention rather than runoff. Soils that are turned over and lap out of these impressions will have reduced surface contamination and will expand the area available for planting. Depending on the spacing between impressions, the amount of land surface that will be disturbed over a given area can vary but can reach nearly one hundred percent. In general, in areas on Stucky Ridge and Smelter Hill conditions it will be necessary to disturb much of the land surface across a given area; however, as noted above, intensive land disturbance will be less necessary on Mount Haggin.

Forest land revegetation will also require surface disturbance in the same manner as grassland revegetation. Grasses and shrubs will also be seeded or planted in the forest land areas to ensure species diversity and to stabilize and protect soil. As in the other categories, revegetation will be based on ecological principles. In particular, core areas or habitat islands will be established to take advantage of site conditions. Integrating the islands into the landscape would optimize the amount and spatial distribution of vegetation types. The islands would provide wildlife habitat, serve as corridors to other islands and areas with existing vegetation, and facilitate recovery of adjacent areas.

As noted, the alternatives principally differ in the percentage of the injured area over

which restoration actions are to occur. The larger the area of vegetation reestablished, the greater the total seed/propagule source, the greater the increase in total organic matter production, the greater volume of precipitation is captured, the greater the amount of erosion reduction, and the greater the prospects for wildlife colonization. All of the alternatives will produce these benefits and promote successional change, but to varying degrees and at varying rates.

7.5.2 Alternative 7A

In this alternative, the entire grossly injured area would be addressed. The critical elements of this alternative are:

- 1) revegetation over (10,966 acres) of the grossly injured area during years 1-12;
- 2) maintain planting levels by replacing dead seedlings, shrubs, and grasses during years 2-13;
- 3) natural recovery.

Under this alternative, revegetation efforts would occur over the three classes of site conditions as described above. Plantings would be maintained to ensure survival. Maintenance will be especially required in areas of steep slope where substantial die-off is to be anticipated.

Since this alternative contemplates somewhat less than one hundred percent soil disturbance, areas between plantings will retain elevated surface concentrations of hazardous substances. In these areas virtually no seed germination will occur. Seeds that manage to germinate will be unlikely to survive.

Over time, the revegetated areas would encroach upon the undisturbed, devegetated areas. A layer of humus should develop as reestablished vegetation sheds organic matter. Invertebrates, which have gradually returned to the core areas, will be recruited to the undisturbed, devegetated areas when metal concentrations are reduced and sufficient organic matter is available. Invertebrates will mix the organic litter with soil from the surface containing elevated levels of metals and with soil from below. This would further reduce metal levels. When surface soil metals concentrations are significantly reduced from present levels, seed germination can occur. In the end, natural processes must be relied on to address remaining contamination and injury.

Because of the magnitude of the injury this process will be extremely slow. Restoration of resources and services to baseline conditions will occur in approximately 200 years.

Notwithstanding the foregoing discussion, in areas where the surface has been disturbed significant benefits to the resource can be realized. With the growth of trees, shrubs, and grasslands, the reestablishment of habitat complexity, and the availability of cover and a forage base, a significant portion of the grossly injured area would again be able to support wildlife. Given the present condition of the upland resource, the establishment of a vegetative community representative of baseline conditions over any part of the grossly injured area would constitute an improvement on the scale of many orders of magnitude. Dramatic improvements would occur in a short period of time--a decade or two--as vegetation takes hold. Substantial recovery would be maximized in approximately 50 years--the length of time for vegetation to reach relative maturity. After the reestablished vegetation reaches maturity, the rate of improvement in the condition of the uplands would slow as restoration becomes a function of natural processes.

7.5.3 Alternative 7B

In this alternative revegetation efforts would occur over 75% of the grossly injured area. The critical elements of this alternative are:

- 1) revegetation over 75% (8,226 acres) of the grossly injured area not addressed by remedy during years 1-9;
- 2) maintain planting levels by replacing dead seedlings, shrubs, and grasses during years 2-10; and
- 3) natural recovery.

Due to the fact that revegetation would extend across approximately 2,700 fewer acres under this alternative as compared to Alternative 7A, restoration of resources and services to baseline conditions would take a few centuries longer under this alternative than under Alternative 7A. The area that is not addressed under this alternative would have to rely entirely on encroachment from the revegetated areas and natural processes for recovery.

The time frame for substantial recovery would be similar under this alternative as under Alternative 7A. For both alternatives the determining factor would be the rate of

vegetation growth, and this should be basically the same for both alternatives. Thus, across 75% of the injured area substantial recovery would occur in the same time frame and to the same approximate degree as substantial recovery will occur across the entire injured area in Alternative 7A.

7.5.4 Alternative 7C

In this alternative revegetation efforts would occur over 50% of the grossly injured area. The critical elements of this alternative are:

- 1) revegetation over 50% (5,483 acres) of the grossly injured area not addressed by remedy during years 1-6;
- 2) maintain planting levels by replacing dead seedlings, shrubs, and grasses during years 2-7; and
- 3) natural recovery.

In this alternative, the reduced extent of the grossly injured area subject to revegetation, as compared to Alternatives 7A and 7B, will lengthen the time for restoration of resources and services to baseline over the other alternatives. Reliance on encroachment and natural processes to restore 5,483 acres, which are not addressed under this alternative, will extend the time to restoration to baseline conditions several centuries beyond what it would take under Alternative 7A.

The time frame for substantial recovery would be similar under this alternative as under Alternatives 7A and 7B. For all three alternatives the determining factor would be the rate of vegetation growth, and this should be basically the same for the alternatives. The extent of substantial recovery under this alternative that will occur across 50% of the area will not be as great as will occur across 75% of the area in Alternative 7B and 100% of the area in Alternative 7A. This is due to the fact that in Alternatives 7A and 7B, substantial recovery was enhanced by revegetation efforts across most or all of the injured area. Under this alternative, half of the area is not being addressed, and this will cause the extent of substantial recovery in that part of the area that is addressed to be markedly less than will occur under Alternatives 7A and 7B.

7.5.5 Alternative 7D

In this alternative revegetation efforts would occur over 25% of the grossly injured area. The critical elements of this alternative are:

- 1) revegetation over 25% (2,743 acres) of the grossly injured area not addressed by remedy during years 1-3;
- 2) maintain planting levels by replacing dead seedlings, shrubs, and grasses during years 2-4; and
- 3) natural recovery.

Under this alternative, 8,223 acres would have to rely on encroachment from vegetated areas and natural processes to return to baseline. Restoration to baseline conditions would occur many centuries beyond the time projected for restoration to baseline under Alternative 7A.

Substantial recovery across 2,743 acres would occur in roughly the same time frame as substantial recovery across each of the areas to be revegetated under the other alternatives. Like Alternative 7C, however, the reduction in the number of acres to be addressed will cause the extent of substantial recovery within these acres to be somewhat less than will occur in the area to be revegetated under Alternative 7C and much less than will occur in the areas to be revegetated under Alternatives 7A and 7B.

7.5.5 Alternative 7E

In this alternative nothing further is done to the grossly injured area. In this event, surface soils will remain contaminated for the foreseeable future, preventing seed germination and revegetation. Due to the persistent nature of hazardous substances, restoration of resources and services to baseline will be on the order of thousands of years, if it occurs at all. Substantial recovery will take somewhat less time, but given the time frames involved the difference between the two measures is not significant.

7.6 Evaluation of Alternatives

7.6.1 Technical Feasibility

The alternatives are roughly equivalent in terms of technical feasibility, with the possible exception of Alternative 7A. This alternative entails revegetating the entire grossly injured area including approximately 2,200 acres of land with a slope of approximately 40%

or greater. Revegetating this steep area will be difficult due to the fact that these areas are eroded, machinery cannot be relied on, and conditions are harsh. Alternative 7A addresses this issue by incorporating into the alternative more intensive measures to protect soil in the steep areas than are planned for the deciduous shrub area or the grassland/bare ground area.

As a general matter, revegetation can be accomplished and restoration and recovery achieved using the techniques described. The methods by which revegetation will occur under the alternatives have been successfully utilized on Smelter Hill and at other sites in the Western U.S. impacted by smelter emissions.

7.6.2 Cost-effectiveness

A distinction between the alternatives cannot be made on cost-effectiveness grounds because the alternatives produce radically different benefits. First, the alternatives vary widely in the amount of acreage revegetated, ranging from 10,966 acres under Alternative 7A to 200 to 400 acres under Alternative 7E. Second, the alternatives result in differing restoration and recovery times. Under Alternative 7A restoration to baseline will occur in 200 years, under Alternative 7E restoration to baseline will not occur for thousands of years.

7.6.3 Results of Response Actions

Response actions that are anticipated to occur across the grossly injured area will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

7.6.4 Potential for Additional Injury

The existing condition of the grossly injured area must be considered in any discussion of the potential for environmental impacts associated with these alternatives. Environmental impacts from the alternatives will be short-term and minor. To the extent impacts occur, these will be largely attributable to emissions of particulate matter as a result of soil disturbance.

7.6.5 Natural Recovery and the Ability of the Resource to Recover

Without intensive restoration actions, the grossly injured area will not be restored for thousands of years. The action alternatives seek to shorten this time frame considerably, and at the same time produce immediate benefits to the resource by revegetating all or a part of the grossly injured area.

As noted, the alternatives range widely. Alternative 7A revegetates 100 percent of the injured area. Substantial recovery of the entire area would be realized in a decade or two and maximized in 50 years. Restoration to baseline would not occur for approximately 200 years. Alternative 7B revegetates 75 percent of the injured area. Substantial recovery in the revegetated area would be realized in a decade or two and maximized in 50 years, but restoration to baseline would take a few centuries longer than it would take under Alternative 7A. Alternative 7C revegetates 50 percent of the injured area. Substantial recovery in the revegetated area would be realized in a decade or two and maximized in 50 years, but in this alternative the level of substantial recovery would be noticeably different than in either Alternative 7A or 7B because a significant portion of the injured area is being left devegetated. Under Alternative 7C restoration to baseline would occur several centuries later than under Alternative 7A. Alternative 7D revegetates 25 percent of the grossly injured area. The time frame for substantial recovery would be the same for this alternative as for the others. The level of substantial recovery obtained under Alternative 7D would be somewhat lower than would be obtained under Alternative 7C and much lower than would be obtained under the other two alternatives. Restoration to baseline under Alternative 7D would not occur for many centuries after the time projected for restoration to baseline under Alternative 7A.

7.6.6 Human Health and Safety

There are no significant human health and safety issues associated with any of these alternatives. Alternatives would be designed and implemented to ensure both workplace safety and public health.

7.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

7.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

7.6.9 Other Relevant Factors

No other relevant factors exist to the State's knowledge.




7.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 7A--\$25 million; Alternative 7B--\$20.7 million; Alternative 7C--\$15.3 million; Alternative 7D--\$8.7 million; and Alternative 7E--\$.5 million. Based on the following analysis and informed by the State's knowledge of the resource, the State selects Alternative 7A.

The alternatives' costs must be looked at in the context of all the relevant factors. In selecting Alternative 7A, the State considered the truly remarkable severity of the injury along with the extremely long recovery periods if no restoration occurred. The benefits to be derived from the selection of Alternative 7A far outweigh the cost of Alternative 7A.

The choice here was between Alternative 7A and 7B because leaving half or more than half of the injured area in its presently devegetated state was simply unacceptable. Alternative 7A was selected over Alternative 7B because it produced substantial recovery in a matter of a decade or two across 2,700 more acres than did Alternative 7B, it restored resources to baseline a few centuries earlier than did Alternative 7B, and it was not significantly more costly to implement than Alternative 7B.

Figure 8-1. Anaconda Area

-  Lake or Pond
-  Tailings
-  Slag Pile



8.0 ANACONDA AREA RESOURCES

8.1 Description of Site and Injury

Disposal, releases, and spills of solid mining wastes, milling debris, smelting by-products, and process fluids occurred over the last 110 years in the Anaconda area. Mining and processing wastes containing hazardous substances have caused injury to the area's groundwater and riparian resources. This chapter addresses five discrete areas of groundwater contamination: Old Works, Smelter Hill, Anaconda Ponds, Opportunity Ponds, and Warm Springs Ponds, and one area of riparian resource injury: Opportunity Ponds.

8.1.1 Old Works

Copper ore mined in Butte was processed at Old Works along Warm Springs Creek from 1883 to shortly after the turn of the century. During this period, tailings and slags were deposited at and around the facility. These wastes contain high concentrations of arsenic, cadmium, copper, lead, and zinc. Waste disposal has injured the alluvial groundwater system around Old Works.

8.1.2 Smelter Hill

In 1902, the Washoe Works (Anaconda Smelter) began operations on Smelter Hill, expanding Anaconda copper production exponentially. By the 1930s, thousands of tons of ore were processed on a daily basis, producing up to one million pounds of copper per day. Infrastructure to support the smelting operations included buildings, waste piles and lagoons, leach pads, rail lines, and all manner of industrial facilities extending across approximately 600 acres of Smelter Hill. In the course of operations, large volumes of hazardous substances were discharged, disposed of, or otherwise released to the environment (airborne emissions from the smelter are discussed in Chapter 7). Both historical and current releases of hazardous substances have injured groundwater in the bedrock aquifer of Smelter Hill with arsenic, cadmium, iron, manganese, zinc, fluoride, sulfate, and total dissolved solids (TDS) at concentrations exceeding drinking water standards. From Smelter Hill, groundwater flows to the east and north to the valley alluvial aquifer and then to the east-northeast toward Opportunity Ponds, eventually discharging to Mill-Willow Bypass, Warm Springs Creek, and the Clark Fork River.

8.1.3 Anaconda and Opportunity Ponds

Tailings from the Washoe operation were deposited in the 700-acre Anaconda Ponds and the 3,400-acre Opportunity Ponds. During smelter operations, over 3.8 million gallons per day of wastewater and tailings slurry were discharged to Anaconda Ponds, and over 30 million gallons per day of wastewater and tailings slurry were discharged to Opportunity Ponds. In the early 1960s, with the opening of the Weed Concentrator at Butte and tailings disposal at Yankee Doodle Tailings Pond above Berkeley Pit, use of Anaconda and Opportunity Ponds diminished. Disposal at the Ponds ceased when the Anaconda Smelter closed.

Tailings disposal has resulted in significant groundwater contamination. For example, groundwater down-gradient of Opportunity Ponds has elevated concentrations of contaminants to depths of at least 70 feet below the ground surface. At the present time, contaminant plumes of arsenic, cadmium, and zinc are smaller than plumes of iron, manganese, sulfate, and TDS. The former set of plumes are found beneath the Ponds only, while the latter set of plumes are found beneath and extend downgradient of the Ponds to the Mill-Willow Bypass and Warm Springs Creek.

8.1.4 Warm Springs Ponds

Prior to 1920, Silver Bow Creek was dammed to create Warm Springs Ponds 1 and 2; Pond 3 was built in the 1950s. In total, the Ponds cover an area of approximately four square miles. These settling Ponds contain mining and smelting wastes from upstream sources that are being transported downstream. Seepage from Warm Springs Ponds has injured groundwater to at least 40 feet below the ground surface as evidenced by exceedances of drinking water standards for arsenic, cadmium, fluoride, iron, manganese, and sulfate.

8.1.5 Volumes and Areas of Injured Resources

The total volume of injured groundwater in the Anaconda area is estimated to be 442,200 acre-feet extending over 40 square miles. Specifically, alluvial and bedrock groundwater exceeds drinking water standards for arsenic, cadmium, iron, manganese, mercury, sulfate, zinc, fluoride, and TDS.

In addition to the groundwater injury, the tailings at Opportunity Ponds are phytotoxic. The absence of vegetation has resulted in a concomitant elimination of wildlife

across the 3400-acre Opportunity Ponds. Thus, soils, vegetation, wildlife, and wildlife habitat at Opportunity Ponds are injured.

8.2 Sources of Hazardous Substances

8.2.1 Old Works Sources

Approximately one million cubic yards of wastes are present in the Old Works Area. Groundwater is exposed to hazardous substances by infiltrating precipitation and by movement of groundwater through contaminated alluvial material. The Old Works area is also a source of contamination for surface water and is discussed in Chapter 9.

8.2.2 Smelter Hill Sources

Sources of hazardous substances to Smelter Hill groundwater are contaminated surface soils and the underlying contaminated bedrock. Surface contamination is most severe at the location of the former smelter complex. In some locations in this area, surface soils are highly contaminated to a depth of at least four feet.

On Smelter Hill, releases of wastes directly to the land surface and, in particular, releases of large volumes of process water, have resulted in extensive surface and sub-surface contamination. As precipitation infiltrates through contaminated surface soils and the unsaturated portion of the bedrock aquifer, hazardous substances are dissolved and transported to groundwater. Similarly, groundwater flowing through the contaminated fractured bedrock aquifer dissolves hazardous substances adhering to aquifer materials. Groundwater contamination extends to a depth of at least 200 feet below the land surface.

8.2.3 Anaconda and Opportunity Ponds Sources

The total volume of waste materials in Anaconda and Opportunity Ponds is approximately 243 million cubic yards, with Anaconda Ponds containing 97 million cubic yards and Opportunity Ponds containing 146 million cubic yards. Hazardous substances are leached from these materials and transported to groundwater. Leaching occurs in two ways. First, as precipitation infiltrates through the tailings contaminants are mobilized off the tailings and are transported to groundwater.

Approximately one-third of the annual precipitation infiltrates through Anaconda and Opportunity Ponds and eventually reaches the water table. The average annual precipitation

in the Anaconda region is 13.7 inches. Consequently, an average of 4.6 inches of precipitation moves through the Ponds and contaminates the underlying aquifer each year.

Second, leaching of metals occurs as groundwater moves through tailings and/or the contaminated alluvial aquifer. The large volume of tailings in contact with groundwater facilitates leaching. The water table is in contact with the tailings across one-half of Opportunity Ponds. At Anaconda Ponds, it appears that a relatively small portion of the tailings are below the water table.

8.2.4 Warm Springs Ponds Sources

Warm Springs Ponds contain about 19 million cubic yards of tailings, contaminated sediments, and sludges. Pond water seeps through contaminated Pond berms and bed sediments and transports contaminants to the underlying groundwater. Groundwater generally flows north from the Ponds, contaminates coarse-grained alluvial material, and discharges to the Clark Fork River and the Mill-Willow Bypass. Releases from Warm Springs Ponds to surface water are discussed in Chapter 9.

8.3 CERCLA Response Actions

To date, a number of actions have been undertaken or are underway in the Anaconda area to reduce or control releases of hazardous substances.

At Old Works, 250,000 cubic yards of wastes were removed and disposed of on Smelter Hill in a lined repository. These wastes were formerly a source of hazardous substances to groundwater. The Record of Decision (ROD) for Old Works prescribed removal of waste, capping waste areas, and revegetation. This work is underway.

On Smelter Hill, 600,000 cubic yards of flue dust, which has been a significant contributor to Smelter Hill groundwater contamination, has been excavated, stabilized, and disposed of in an on-site repository. In addition, approximately 150 acres within the 600-acre industrial area was covered with soil and revegetated.

At Warm Springs Ponds, levees/dams have been raised and strengthened, Mill-Willow Bypass has been reconstructed, and contaminated groundwater is being intercepted downgradient of Pond 1 to reduce releases of hazardous substances to the Clark Fork River. Pond 1 is being wet and dry-closed, meaning that exposed tailings will be covered with water or soil. Although EPA has stated that it expects its selected remedies at Warm Springs

Ponds to be permanent, EPA will make a final decision on the fate of the Ponds after upstream cleanup.

Remedial Investigation/Feasibility Studies (RI/FS) for the Anaconda area are underway. With the exception of Warm Springs Ponds, a ROD for the remaining parts of the Anaconda area is anticipated in 1996. Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that the following actions will be implemented in the Anaconda area:

- 1) implementation of institutional controls to prohibit the use of groundwater in contaminated areas and to prohibit access to Opportunity and Anaconda Ponds;
- 2) placement of crushed limestone over Opportunity and Anaconda Ponds for erosion control;
- 3) revegetation of an additional 200 acres within the industrial area on Smelter Hill.

8.4 Residual Injury

Response actions in the Anaconda area will not restore resources and services to baseline conditions, nor are they intended to. Actions at Old Works are addressing groundwater injury by removing and isolating contaminated materials and by decreasing infiltration of precipitation through contaminated soils and waste materials. This will significantly reduce contaminant loadings to the aquifer.

On Smelter Hill, response actions are expected to address the most highly contaminated areas. While this action will reduce contaminant loadings to groundwater, the degree of reduction is unknown. It is possible, even likely, that metal contamination in the saturated zone of the bedrock is so extensive that addressing surface sources of contamination will not significantly reduce contaminant groundwater concentrations.

The extent of groundwater injury at Opportunity Ponds and Anaconda Ponds will not decrease as a result of response actions. In addition, injury to soils, vegetation, wildlife habitat, and wildlife at Opportunity Ponds will go unmitigated.

At Warm Springs Ponds, wet and dry-closure at Pond 1 is expected to reduce contaminant loadings to groundwater. The extent and severity of groundwater injury caused

by sources of contamination in Ponds 2 and 3 will not decrease as a result of response actions. However, the discharge of contaminated groundwater to the Clark Fork River will largely, or completely, cease.

8.5 Restoration Alternatives

8.5.1 Introduction

The following alternatives do not include removal of waste sources at Old Works, Smelter Hill, Anaconda Ponds, Opportunity Ponds, or Warm Springs Ponds. Removal actions were considered but were rejected for further analysis because of issues related to the volumes and characteristics of the materials involved. Furthermore, as discussed, response actions at Old Works, Smelter Hill, and Warm Springs Ponds are expected to mitigate groundwater injury, however slightly.

Pumping and treating contaminated groundwater at various locations in the area was also considered but rejected for further analysis because of the volume of contaminated groundwater and the extent of contamination. In particular, consideration was afforded to establishing a line of wells at the toe of Opportunity Ponds in order to prevent further migration of the manganese, iron, sulfate, and TDS plumes. However, this would require pumping and treating very large volumes of groundwater indefinitely. Consideration was also afforded to pumping and treating the arsenic, cadmium, and zinc plumes beneath the Ponds. However, this would also necessitate pumping and treating indefinitely, and since it would not directly address the source of contamination, would not substantially decrease the time to recovery.

Alternatives displayed here seek to mitigate additional future groundwater injury at one or both of the Ponds and provide wildlife habitat at Opportunity Ponds. Reduction of metal loadings to groundwater and the creation of limited wildlife habitat can be achieved by grading, capping, and revegetating the Ponds. Capping the tailings will reduce contaminant loadings to groundwater by infiltration and provide a medium to support vegetation.

Oxidation of pyrite (a mineral contained in mine tailings) produces acid mine drainage, which leaches contaminants from the wastes. The rate of oxidation of pyrite is strongly dependant on the amount of oxygen the pyrite is exposed to. A cap would decrease the amount of available oxygen in the tailings and underlying aquifer by decreasing diffusion

of oxygen through the tailings and decreasing the amount of infiltrating water containing dissolved oxygen. In the oxidation of pyrite, 8 mg/l of oxygen produces approximately 12 mg/l of sulfate or sulfuric acid. Consequently, if the amount of dissolved oxygen is decreased, the amount of sulfuric acid produced will decrease commensurately, and concentrations of hazardous substances in groundwater will decrease.

With a cap, over time the tailings will oxidize more slowly, less acid mine drainage will be produced, and lower concentrations of contaminants will be present. Thus, a decrease in the percentage of infiltrating groundwater through the Ponds will result in a direct, and substantial, decrease in the concentrations of contaminants in groundwater below the Ponds.

A cap may also reduce the level of the water table at the Ponds and the degree to which the water table fluctuates on a seasonal basis. Reducing the amount of tailings in contact with groundwater will result in a concomitant decrease in metal loadings to groundwater.

Finally, as noted above, contaminated groundwater is presently discharging to Warm Springs Creek and the Clark Fork River. With a cap, particularly a cap at Opportunity Ponds, as the contaminant plumes move downgradient toward the Creek and the River, the concentrations of contaminants in groundwater discharging to these surface water bodies will be substantially less than they would be without the presence of the cap.

Erosion, root action, or deterioration of the cap materials may render the metals in the tailings accessible to the vegetation, causing vegetative die-off, and a reversion of all or part of the Ponds to their present state. Thus, a cap will require long-term maintenance.

As discussed in Section 1.2.2, restoration actions will be coordinated to the maximum possible extent with CERCLA response actions. It is estimated that remedy will entail the placement of crushed limestone on the Ponds. Issues, to the extent any exist, concerning the integration of this remedy with restoration actions will be addressed as part of a coordinated approach between restoration and response authorities.

8.5.2 Alternative 8A

By capping and revegetating Opportunity and Anaconda Ponds, this alternative seeks to reduce contaminant loadings to groundwater and restore wildlife habitat. Under this

alternative, precipitation infiltration is reduced as much as possible. The key elements of this alternative include:

- 1) Grading Opportunity and Anaconda Ponds;
- 2) Constructing a multilayer cap, that includes a low permeability layer, for Opportunity and Anaconda Ponds;
- 3) Creation of lakes and wetlands;
- 4) Revegetating Opportunity Ponds with native grasses and small shrubs;
- 5) Revegetating Anaconda Ponds to ensure a viable vegetative cover and prevent erosion; and
- 6) natural recovery.

The ponds would be regraded to facilitate drainage and construction of a cap. After grading, a 45-inch thick multilayer cap would be constructed. The upper six inches of tailings would be mixed with three to five percent of bentonite clay to form a low permeability layer. Three inches of crushed limestone would be placed over the tailings/bentonite layer, and 12 inches of slag would be placed over the crushed limestone to serve as a capillary fringe and prevent metals from wicking up from the surface of the ponds to the upper layers of the cap. Overlying the slag will be a 12-inch layer of unconsolidated fill covered by a 12-inch layer of growth media. In those areas of the Ponds that are soft--estimated at 50 percent of the surface of the Ponds--a geogrid (a material resembling a heavy gage plastic fish net) would be laid down prior to placing the crushed limestone.

This cap would virtually eliminate the infiltration of precipitation into the tailings. About one percent of the annual precipitation would infiltrate through the cap, constituting a reduction in infiltration of 97 percent over existing conditions.

There is ample material for cap construction in the area surrounding Opportunity Ponds. Material for the 12-inch thick fill and 12-inch thick growth media layers would be obtained from a series of borrow pits around the perimeter of Opportunity Ponds. This will minimize haul distances, and hence control cost. The borrow areas would be excavated in a manner to facilitate reclamation of the pits into lakes and wetlands. If the average depth of the borrow pits was 25 feet below existing ground surface, approximately 340 acres would be necessary to construct the cap.

Following construction of the cap, the Ponds will be revegetated. Since Opportunity Ponds has been determined to be injured in terms of soil, vegetation, wildlife, and wildlife habitat, it will be revegetated with native grasses and shrubs to promote recovery of these resource values and services. Revegetation at Anaconda Ponds, which was not determined to be so injured, will occur solely for the purpose of ensuring that the cap works as intended.

Restoration actions under this alternative will not restore resources and services to baseline in a reasonable time frame. Restoration to baseline conditions will occur when the metals in primary sources (tailings) and secondary sources (aquifer materials) have been transported out of the system. It is estimated this will take thousands or tens of thousands of years.

However, Alternative 8A will provide substantial benefits even if the alternative does not accelerate the time frame for restoration to baseline. Grading and revegetating the Ponds would reduce contaminant loadings to groundwater as infiltration decreases. Thus, while groundwater would remain contaminated, concentration levels may be significantly lower than at present, and the components of this alternative will probably halt the spread of contamination.

In addition, given the existing condition of Opportunity Ponds, the establishment of a viable vegetative community would represent a substantial recovery of riparian resources. While revegetation of Opportunity Ponds would not represent baseline conditions and would not advance natural recovery, it would provide wildlife habitat where there is presently none. Substantial recovery would occur in the time it takes to reestablish vegetation, or approximately ten years.

8.5.3 Alternative 8B

This alternative is identical to Alternative 8A except that the low permeability tailings/bentonite layer would not be included in the multilayer cap. The key elements of this alternative include:

- 1) Grading the Ponds;
- 2) Constructing a multilayer cap for the Ponds;
- 3) Creation of lakes and wetlands;
- 4) Revegetating Opportunity Ponds with native grasses and small shrubs;

- 5) Revegetating Anaconda Ponds to ensure a viable vegetative cover and prevent erosion; and
- 6) natural recovery

The elimination of the six-inch low permeability layer will result in an increase in infiltration over Alternative 8A. However, the increase is expected to be small. The cap proposed under Alternative 8B will reduce infiltration to groundwater to an average of approximately 5 percent of the annual average precipitation. Consequently, this alternative results in an 85 percent reduction in infiltration over existing conditions.

With more infiltration under this alternative than would occur under Alternative 8A, it is possible that more tailings would remain in contact with groundwater than would be the case under Alternative 8A. This, too, will cause an increase in contaminant concentrations over Alternative 8A.

Under this alternative, it will take thousands or tens of thousands of years to restore resources and services to baseline. However, as is the case with Alternative 8A, decreasing the rate of infiltration will reduce contaminant concentrations from existing conditions. As noted, not incorporating bentonite into the cap will cause slightly higher contaminant concentrations than will exist under Alternative 8A. Restoration of wildlife habitat will occur to the same extent and in the same time frame as under Alternative 8A.

8.5.4 Alternative 8C

Under this alternative Opportunity Ponds would be capped and revegetated but not Anaconda Ponds. The key elements of this alternative include:

- 1) grading Opportunity and Anaconda Ponds;
- 2) constructing a multilayer cap for Opportunity Ponds;
- 3) revegetating Opportunity Ponds with native grasses and small shrubs;
- 4) directing runoff from Anaconda Ponds to a lined storage pond;
- 5) constructing a treatment plant; and
- 6) natural recovery.

In this alternative Anaconda Ponds would not be capped. Instead, Anaconda Ponds would be graded and surface runoff would be collected and channeled to a 34-acre lined storage pond. A small treatment plant would be constructed to treat the contaminated runoff.

from present conditions as a result of grading the Ponds and directing runoff away from the Ponds. Injuries to wildlife and wildlife habitat would not be mitigated. It will take thousands or tens of thousands of years to restore resources and services to baseline.

8.5.6 Alternative 8E

Under this alternative, no further action is taken at the site beyond the CERCLA response action. It is estimated that restoration of resources and services to baseline may occur in thousands or tens of thousands of years when all the metals have migrated out of the area.

8.6 Evaluation of Alternatives

8.6.1 Technical Feasibility

Alternatives that employ a cap must be considered separately from alternatives that do not in the evaluation of this factor. Alternatives 8D and 8E, since they do not employ a cap, are technically feasible and are equivalent in terms of this factor. Alternatives 8B and 8C propose the same kind of cap. Thus, they are equivalent in terms of technical feasibility. Alternative 8A proposes a cap with a low-permeability layer. Thus, it must be considered separately from Alternatives 8B and 8C.

Alternative 8E, natural recovery, proposes doing nothing beyond remedy at Opportunity and Anaconda Ponds. It strains credulity to state that such an alternative employs well-known technologies that have a reasonable chance of successful completion in an acceptable period of time, when that alternative will do nothing to improve the condition of the resource and will result in restoration to baseline in tens of thousands of years, or basically the next ice age. But, given the massive scale at this site, the intractable nature of the problem, the seeming lack of solutions with the exception of excavating the entire volume of tailings in the Ponds, and the inability to accelerate recovery times under any alternative, Alternative 8E is as technically feasible as any other.

Alternative 8D, which calls for grading the Ponds and the construction of a treatment plant is technically feasible. Grading the Ponds will reduce infiltration. A treatment plant can be constructed. Accordingly, the elements of this alternative can be performed and will accomplish their intended purpose.

Alternatives 8B and 8C propose a cap over both (Alternative 8B), or one of

(Alternative 8C), the Ponds. The cap proposed under these alternatives would not have a low-permeability layer, like the cap proposed under Alternative 8A. While caps have been utilized at tailings ponds, their use is relatively recent. Thus, there is uncertainty over their long-term viability. The concern is that over time metals from the surface of the Ponds will wick up into the root zone of the cap and cause vegetative die-off. Another concern is that the cap materials will be eroded or will lose their integrity over time. A final concern is that, to NRDLP's knowledge, such a cap has never been utilized on tailings ponds the size of Opportunity Ponds and Anaconda Ponds. In any event, a cap would need to be maintained basically forever.

The concerns expressed in the preceding paragraph also apply to Alternative 8A. Inclusion of the low-permeability layer provides greater assurance that metals will not reach the root zone through wicking. However, given the uncertainties involved, it cannot be claimed that Alternative 8A is more technically feasible than either Alternative 8B or 8C.

8.6.2 Cost-effectiveness

A distinction between the alternatives cannot be made on cost-effectiveness grounds because the alternatives do not provide a similar level of benefits. The alternatives vary widely in the amount of precipitation that would infiltrate to groundwater. Reducing infiltration will reduce contaminant concentrations in groundwater and improve the condition of the resource.

Notwithstanding a reduction of infiltration rates proposed by the alternatives, groundwater resources are expected to remain injured. Restoration to baseline would take equally long under all of the alternatives. Additionally, at present, there appears to be no way to quantify the benefits to the groundwater resource from a reduction in infiltration.

Alternatives that propose to cap Opportunity Ponds produce different benefits than alternatives that do not propose to cap Opportunity Ponds. Capping Opportunity Ponds will produce some measure of wildlife habitat where there is presently none. Under the capping alternatives wetlands will be created and this will also benefit wildlife values.

Finally, alternatives that propose to cap either or both Ponds will lessen wind erosion off the surface of the Ponds. The Ponds have been identified as a potential source of hazardous substances to injured upland terrestrial resources.

8.6.3 Results of Response Actions

Response actions will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources. The groundwater injury in the Anaconda area is truly massive. Over 400,000 acre-feet of groundwater, extending over 40 square miles, has been injured. Approximately 5 square miles of wildlife habitat has been lost. These injuries will remain following remedy.

Under all the action alternatives it will be necessary to coordinate with remedy regarding the application of the three-inch limestone layer projected to occur under remedy. The alternatives assume such coordination will occur. Should coordination prove impossible this plan will need to be revised.

8.6.4 Potential for Additional Injury

At the present time, it appears that all the action alternatives are basically equivalent with regard to this factor. Alternatives 8C and 8D will require the construction of a treatment plant, which will result in minor environmental impacts. Construction across the surface of the Ponds will cause emissions of particulates under all the action alternatives. Borrow areas will be converted to wetlands, which will produce benefits to riparian resources.

Alternative 8E may result in a significant impact far into the future. It has been posited that in thousands of years oxidation of all the tailings in Anaconda and Opportunity Ponds will occur, at which time there could be a flush (occurring over an extended period of time) of contaminants out of the tailings to groundwater. This could result in plumes of contamination expanding significantly. In such an event, for example, the plume of arsenic at Opportunity Ponds could extend to the Clark Fork River.

A massive release of contaminants is a risk under all the action alternatives. But, because the action alternatives reduce infiltration, the risk of such an occurrence may be less under these alternatives than the risk associated with Alternative 8E. The degree to which this risk is reduced is uncertain; presumably the greater the level of infiltration reduction, the longer it will take the Ponds to oxidize, the more metals will be released over the period of time until oxidation, and the lower contaminant concentrations would be if this flush of

contaminants were to occur.

8.6.5 Natural Recovery and the Ability of the Resource to Recover

Restoration to baseline for the groundwater resource will take tens of thousands of years under all the alternatives. Similarly, wildlife habitat restoration will take thousands of years. Furthermore, and as noted above, it is difficult to assess the relative benefits to groundwater from the implementation of the alternatives. Capping Opportunity Ponds would, however, result in some measure of wildlife habitat recovery in a relatively short period of time. Finally, benefits from a cap may be transitory.

8.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Hazardous substances reside in and on the Ponds. Thus, appropriate and applicable requirements for the handling of such materials would be complied with. Workplace safety would be ensured and the alternatives designed and implemented so that the public safety would be protected.

8.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

8.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Moreover, before implementing the alternatives, the State would obtain all necessary permits and authorizations.

8.6.9 Other Relevant Factors

All relevant factors identified at this time have been identified in the foregoing discussion.

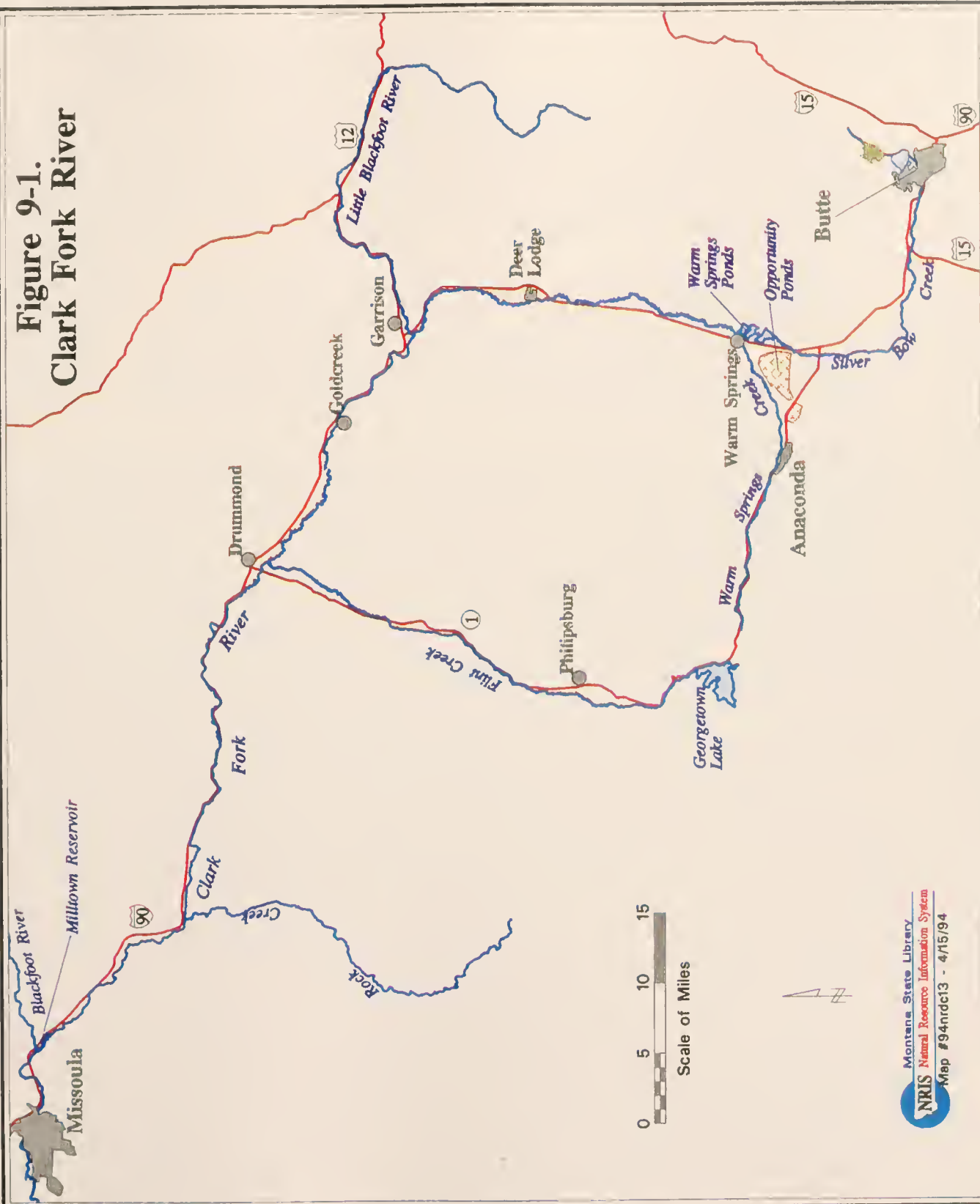
8.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 8A--\$287.2 million; Alternative 8B--\$145.2 million; Alternative 3C--\$121.6 million; Alternative 8D--\$43.6 million; and Alternative 8E--\$.9 million. Based on the following analysis and informed by the previous discussion and the State's knowledge of the resource, the State selects Alternative 8E.

In the final analysis, two issues were dispositive. First, and with regard to the alternatives' aim to reduce infiltration, the benefits of such a reduction in infiltration to groundwater simply could not be identified at this time. Thus, while it was understood that the alternatives would, in varying degrees, reduce infiltration, the State was unable to determine what this would mean for contaminant concentrations in groundwater, or what this would mean for the massive release scenario presented above.

Second, given the State's inability to fully assess the benefits to groundwater from any of the action alternatives, it was deemed inappropriate to require the expenditure of tens or hundreds of millions of dollars. Nor could such an expenditure be justified looking solely at the recovery of some measure of wildlife habitat across Opportunity Ponds.

**Figure 9-1.
Clark Fork River**



9.0 CLARK FORK RIVER AQUATIC AND RIPARIAN RESOURCES

9.1 Description of Site and Injury

Aquatic and riparian resources of the Clark Fork River from Warm Springs to Milltown Reservoir have been injured by the hazardous substances arsenic, cadmium, copper, lead, and zinc released from mining and mineral-processing operations in the Butte and Anaconda areas. This reach of the river is a unit of the Milltown Reservoir/Clark Fork River NPL Site.

The headwaters of the Clark Fork River are formed by Warm Springs Creek and the Mill-Willow Bypass. Approximately 124 miles downstream is the Milltown Reservoir, an impoundment created by Milltown Dam at the confluence of the Clark Fork and Blackfoot Rivers.

Silver Bow Creek carried wastes from mining and milling operations in the Butte area directly to the Clark Fork River and its floodplain prior to the construction of Warm Springs Ponds. Three ponds were constructed on Silver Bow Creek near the town of Warm Springs to treat wastes and associated contaminated sediments in Silver Bow Creek. The Ponds release hazardous substances to the Clark Fork River via the Mill-Willow Bypass. Mining and smelting wastes deposited along Warm Springs Creek near Anaconda have also contributed hazardous substances to the Clark Fork River.

Large areas of the Clark Fork River's floodplain from Warm Springs to the Milltown Reservoir, including the river's banks, are contaminated by hazardous substances. Floodplain contamination consists of tailings, mixed alluvium and tailings, and contaminated soils. Tailings and contaminated soils are cycled back and forth between aquatic and riparian environments. Floodplain tailings and contaminated soils contaminate surface water and bed sediments through releases of hazardous substances by surface runoff, scouring during bank full and overbank high flows, and riverbank wasting and slumping. Similarly, hazardous substances are deposited on the floodplain during overbank high flows.

Benthic macroinvertebrates living in and on the riverbed have accumulated hazardous substances in their tissues. Consumption of benthic macroinvertebrates by trout results in exposure and injury, including death and reduced growth. Populations of otter, mink, and

raccoons that rely on fish and benthic macroinvertebrates in their diets are significantly reduced relative to baseline conditions.

Contaminated floodplain deposits have injured riparian resources, depriving wildlife of habitat. The most severe floodplain contamination, as evidenced by the occurrence of devegetated or sparsely vegetated tailings deposits, occurs between Warm Springs and Deer Lodge. In general, concentrations of hazardous substances in floodplain deposits and the occurrence of devegetated tailings decrease in a downstream direction. Like the floodplain, the severity of riverbed and bank contamination decreases with distance from the Ponds.

Natural resource injuries to the Clark Fork River from releases of hazardous substances is demonstrated in the following ways:

- 1) Surface water contains concentrations of hazardous substances that exceed criteria established for the protection of aquatic life and thresholds that have been demonstrated to cause injury to fish.
- 2) Bed sediments contain hazardous substances at concentrations that exceed baseline conditions by, on average, a factor of more than ten, and exceed concentrations that are expected to injure benthic macroinvertebrates.
- 3) Benthic macroinvertebrate tissues contain hazardous substances. Consumption of these contaminated benthic macroinvertebrates by trout has been shown to cause reduced growth and survival.
- 4) Trout populations are approximately one-sixth (about 17%) of baseline due to exposure to contaminated surface water and consumption of contaminated benthic macroinvertebrates. Rainbow trout are largely absent from the Clark Fork River upstream of its confluence with Rock Creek.
- 5) Populations of otter, mink, and raccoons that rely on fish and benthic macroinvertebrates in their diets are significantly reduced relative to baseline conditions. Otter are completely absent from the Clark Fork River.
- 6) 215 acres of floodplain contain phytotoxic concentrations of hazardous substances and are therefore entirely or largely devoid of vegetation. These areas have no or little capacity to support viable wildlife populations.

- 7) Thousands of additional floodplain acres contain tailings and contaminated soils and are a continuing source of hazardous substances to aquatic and riparian resources.

9.2 Sources of Hazardous Substances

Numerous waste sources contribute to injuries in the Clark Fork River. These include sources to groundwater and surface water in Area One described in Chapter 3, and floodplain tailings and soils and bed sediments in Silver Bow Creek described in Chapter 4. Contaminated groundwater beneath the Opportunity Ponds and the Warm Springs Ponds are also sources to the Clark Fork River and are discussed in Chapter 8. Sources discussed in this chapter include tailings and contaminated soils in the Clark Fork River floodplain, bed and bank sediments of the Clark Fork River, discharges from Warm Springs Ponds, and wastes along Warm Springs Creek.

The Clark Fork River floodplain from Warm Springs to Milltown Reservoir is contaminated by hazardous substances. The areal extent of floodplain contamination has been estimated at over 13,000 acres. More than 4,500 acres of floodplain contain exposed tailings, mainly in the reach between Warm Springs Ponds and Drummond. Metals-enriched soils cover approximately 9,000 additional acres of floodplain extending along the entire length of the river between Warm Springs and Milltown Reservoir.

Release mechanisms differ for aquatic resources and riparian resources. As noted, tailings and contaminated soils and sediments are cycled between the floodplain and the River. Hazardous substances in the floodplain are released to surface water and bed sediments by surface runoff over exposed surfaces, scouring during bankfull and overbank high flows, and riverbank wasting and slumping. Contaminated bed sediments and floodplain deposits are also reentrained and redeposited on the floodplain by overbank high flows. In addition, at high water stage the Clark Fork River carries increased quantities of contaminated suspended sediments from reaches upstream to those downstream. As high waters recede contaminated material is redeposited in bed, bank, and floodplain areas. For riparian resources, release mechanisms include geochemical oxidation/reduction and desorption processes in contaminated floodplain tailings and soils. These processes increase the bioavailability of hazardous substances to riparian vegetation.

Warm Springs Ponds, which partially treats the contaminated waters of Silver Bow Creek, discharges continuously to the Clark Fork River via the Mill-Willow Bypass. The Ponds' discharges are a source of hazardous substances to the River. The Warm Springs Ponds' discharges are being addressed by CERCLA response actions and are discussed in Section 9.3.

Finally, wastes from smelting operations in the Anaconda area were deposited along Warm Springs Creek, which is a headwaters tributary of the Clark Fork River. Hazardous substances have entered Warm Springs Creek by surface runoff over waste sources and during high flows that reentrain floodplain wastes. These wastes have been, and will be, addressed by CERCLA response actions as discussed in Section 9.3.

9.3 CERCLA Response Actions

To date, response actions have been undertaken or are underway to reduce or control releases of hazardous substances to the Clark Fork River. These include:

- 1) isolating wastes along Warm Springs Creek by levee reconstruction, detention basin construction, and floodplain engineering;
- 2) removing tailings in and reconstructing the Mill-Willow Bypass;
- 3) upgrading the treatment capacity and efficiency of Warm Springs Ponds; and
- 4) closing Warm Springs Pond 1, with installation of a groundwater collection and pumping facility to reduce the discharge of contaminated groundwater to the Clark Fork River.

The Remedial Investigation/Feasibility Study (RI/FS) for the Clark Fork River has not yet begun. A Record of Decision (ROD) selecting a preferred alternative is anticipated in 1997. The RI/FS will evaluate different remedial options for floodplain tailings, including removal with on-site or off-site disposal and in-situ immobilization of hazardous substances by a technique known as STARS (Streambank Tailings and Revegetation Study). STARS entails the addition of lime and other calcium compounds to tailings and contaminated soils and revegetating the amended area with acid and/or metal tolerant plant species, primarily grasses. Lime neutralizes acid pH conditions in tailings and contaminated soils, which immobilizes hazardous substances and permits the reestablishment of vegetation. By these mechanisms STARS seeks to prevent hazardous substances from reaching surface water by

runoff or groundwater by leaching.

In 1990, tailings along approximately 3,200 lineal feet of the Clark Fork River immediately downstream of the River's headwaters at Warm Springs, covering approximately 78 acres, were limed and revegetated. Monitoring to evaluate the effectiveness of this action is ongoing.

Based on a review of the RI/FS literature, an evaluation of actions implemented or planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES personnel, it is estimated that the following actions are likely to be implemented at the Clark Fork River:

- 1) tailings immediately adjacent to the Clark Fork River will be excavated and relocated to revegetated areas further away from the river;
- 2) tailings and associated contaminated soils, including relocated tailings, will be treated with lime and revegetated (STARS);
- 3) riverbanks in STARS-treated areas will be stabilized; and
- 4) grazing will be managed to protect STARS-treated floodplain areas.

It is estimated that the remedy will occur over approximately 400 acres of floodplain, and will address approximately ten percent of the riverbanks, largely in the reach of the Clark Fork River between Warm Springs and Deer Lodge.

9.4 Residual Injury

The remedy will not return aquatic and riparian resources to baseline, nor is it intended to. After implementation of the remedy, sources of hazardous substances will remain, causing injuries to aquatic and riparian resources.

Hazardous substances not addressed by the remedy are located on the contaminated floodplain, riverbanks, and riverbed of the Clark Fork River between Warm Springs and Milltown Reservoir. Sources include approximately 9,000 acres of metals-enriched soils, 4,100 acres of untreated tailings-impacted floodplain, contaminated riverbanks and riverbed sediments along 120 miles of riverchannel, and the 400 acres of STARS-treated floodplain.

In addition, notwithstanding the upgrading of treatment at Warm Springs Ponds, releases of hazardous substances from the Ponds to the Clark Fork River will continue to occur. These releases will cause hazardous substance concentrations in the River to exceed

baseline conditions. On occasion, concentration levels will be greatly elevated and will result in exceedances of water quality criteria in the Clark Fork River.

Remedial activities along Warm Springs Creek will greatly reduce releases of hazardous substances to the Creek. Therefore, sources of hazardous substances to Warm Springs Creek will not be discussed further in this chapter.

Important to a discussion of residual injury are the inherent limitations of STARS. STARS is a source control technique that seeks to reduce releases of hazardous substances to surface water and groundwater by establishing a vegetative cover on contaminated floodplain tailings and soils; thereby reducing releases of hazardous substances to surface water and groundwater. Even if STARS accomplishes what is intended, significant residual injury will exist. Hazardous substances will remain in floodplain tailings and soils at concentrations exceeding baseline conditions. These concentrations will be phytotoxic to many native species. This, and STARS' dependence on acid and/or metals tolerant grass and shrub species for revegetation, will result in poor vegetative diversity and a continuing reduction in wildlife habitat over the STARS-treated area.

Additionally, hazardous substances residing in the STARS treated floodplain will be eroded and remobilized by storm-event and snowmelt runoff and by overbank high-flows. Exposed soils will exist within the STARS treated area since vegetation cannot completely cover the land surface. Erosion will occur from these exposed areas of the floodplain and, to a lesser extent, from areas that are revegetated. Contamination of bed sediments and surface water will continue to occur as a result of these processes. Finally, stream channel migration will, over time, intercept STARS-treated floodplain materials and remobilize contaminated floodplain soils, thereby contaminating bed sediments and surface water.

An additional concern is the effectiveness of STARS in maintaining a permanent vegetative cover. At present, the Natural Resource Damage Litigation Program (NRDLP) believes there is a risk that over time the neutralization capacity of lime-amended soils will be depleted, causing pH levels to decrease and vegetation to die. In such an event, wildlife habitat would be lost and hazardous substances would become more available to remobilization by surface runoff and overbank high flows.

In conclusion, after implementation of CERCLA response actions aquatic and riparian

resources will remain injured. Concentrations of hazardous substances in surface water will exceed baseline. Hazardous substances in contaminated riverbed sediments will continue contaminating benthic macroinvertebrates, thereby injuring trout and other animals that rely on benthic macroinvertebrates in their diet. Trout populations will remain depressed compared to baseline conditions due to the continuing contamination of surface water, bed sediments, and benthic macroinvertebrates.

Residual injury to riparian resources will exist notwithstanding an effective STARS remedy. While vegetation will be reestablished on approximately 400 acres, the use of metals and/or pH tolerant grass and shrub species will result in a continuing reduction in vegetative diversity, the number of riparian habitat layers, and the number of viable wildlife species.

9.5 Restoration Alternatives

9.5.1 Introduction

As a preliminary matter, it should be noted what is not proposed by the following restoration alternatives. First, no alternative proposes to remove all floodplain contamination. It is estimated that at least 13,000 acres of floodplain along the entire length of the Clark Fork River between Warm Springs and Milltown Reservoir are contaminated. Alternatives are proposed that target the most significant source of contamination, namely the 4,500 acres of floodplain that contains exposed tailings. No alternative addresses the 9,000 acres of floodplain containing metals-enriched soils. While removal of all floodplain contamination was considered, it was rejected for further analysis because of the difficulties associated with, and the adverse impacts anticipated from, such an extensive removal action.

Second, no alternative proposes to remove bed sediments. Among the reasons for rejecting bed sediments removal for detailed consideration are that it would be necessary to construct facilities over 120 miles of river to dewater the sediments and treat the contaminated water.

Third, no alternative specifically targets removal and reconstruction of contaminated banks below Deer Lodge. Bank contamination between the Ponds and Deer Lodge is a significant source of hazardous substances to the River and warrants removal consideration. Bank removal below Deer Lodge was rejected for further analysis because it is not as

significant a source as banks upstream. Removal of floodplain contamination upstream of Deer Lodge will indirectly address riverbank contamination below Deer Lodge.

Understanding and analyzing the following restoration alternatives requires that a distinction be made between riparian areas determined to be injured by hazardous substances and riparian areas identified as a source of hazardous substances to injured aquatic resources. Two-hundred fifteen acres of riparian resources were determined to be injured. Therefore, 215 acres of floodplain can be restored to a baseline condition. The remaining areas of contaminated floodplain are not injured, but are a source of hazardous substances to aquatic resources. Actions in these areas would be undertaken not to restore riparian resources but to remove a source of hazardous substances to injured aquatic resources.

In Section 9.3, NRDLP anticipated that STARS would be a significant part of the remedy for the Clark Fork River. Since a remedy that utilizes STARS will not result in the restoration of resources and services alternatives are proposed that would conflict with remedy if STARS is implemented prior to the restoration action. However, as discussed in Section 1.2.2., restoration planning will be coordinated, to the maximum possible extent, with response action planning. Such coordination seeks to ensure that restoration actions do not conflict with the chosen response action. As part of this coordination, various agencies involved in response and restoration actions are engaged in ongoing discussions concerning STARS. Based on these discussions, this plan may be revised.

9.5.2 Alternative 9A

This alternative contemplates extensive removal of contaminated floodplain and riverbank materials that are sources of hazardous substances to the Clark Fork River, and restoration of riparian resources. The key elements of this alternative include:

- 1) excavating 4,500 acres of tailings and related floodplain contamination;
- 2) disposing of excavated materials at Anaconda and/or Opportunity Ponds;
- 3) partial backfilling of excavated floodplain areas;
- 4) revegetating excavated floodplain areas;
- 5) removing, reconstructing, and stabilizing contaminated riverbanks between Warm Springs and Deer Lodge;
- 6) management of grazing to allow vegetation to reestablish;

- 7) flow augmentation; and
- 8) natural recovery.

Under this alternative, 4,500 acres of tailings and associated floodplain contamination containing approximately 2,791,000 cubic yards of material would be excavated. Excavation would occur mainly between Warm Springs and Drummond. Excavated materials would be disposed of at the Anaconda and/or Opportunity Ponds.

Following excavation, the floodplain would be partially backfilled, recontoured and revegetated with species of native grasses, shrubs, and trees. An area equal to the extent of riparian wildlife habitat injury (215 acres) would be replanted to reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. The remaining 4,285 acres of excavated floodplain would be revegetated to stabilize excavated areas and prevent erosion. Grazing would be managed for a short period of time to facilitate revegetation.

Riverbanks between Warm Springs and Deer Lodge not addressed by remedy would be excavated and reconstructed, or stabilized by revegetating with willows and other native shrubs. One-half of the riverbanks would be excavated and reconstructed to remove contaminated bank sediments; one-half would be stabilized by revegetation to reduce slumping and mass-wasting of contaminated bank material into the Clark Fork River. Riverbank removal, reconstruction, and stabilization would reduce releases of hazardous substances to surface water and bed sediments.

To further address residual surface water and riverbed contamination, flows in the Clark Fork River would be augmented by 50 cubic feet per second for two months (mid-July to mid-September) each year. This would be accomplished by acquiring approximately 6,150 acre-feet of water. Flow augmentation would improve water quality by diluting hazardous substances resulting from residual floodplain and riverbed contamination and releases from the Warm Springs Ponds. By entraining sediment, higher flows would also result in less sedimentation of the riverbed. This would reduce exposure of benthic macroinvertebrates to hazardous substances.

Under this alternative, riparian resources would substantially recover as replanted vegetation matures. Revegetated floodplain areas would provide substantially improved wildlife habitat in about 20 years as native shrubs and grasses mature. Wildlife habitat close

to a baseline condition would be achieved in approximately 50 years, the length of time necessary for cottonwood groves that are a significant component of the riparian shrub/tree habitat to achieve substantial growth.

Aquatic resources would substantially recover in ten to twenty years. By removing the most contaminated areas of the floodplain and removing, reconstructing, and stabilizing riverbanks between Warm Springs and Deer Lodge, which are also sources of contamination to the Clark Fork River, the frequency and intensity of loadings of hazardous substances to the Clark Fork River would be measurably reduced. Source removal actions in upstream reaches of the River would benefit downstream reaches by reducing the migration of hazardous substances. Flow augmentation would ameliorate, but not eliminate, the toxicity of residual surface water and bed sediment contamination. These actions would clearly benefit trout populations by reducing exposure to hazardous substances through contaminated surface water and benthic macroinvertebrates. It is estimated that trout populations would quadruple, or increase by 300% (but return to only about 70% of baseline) because of the overall reduction in hazardous substance loadings to the Clark Fork River.

Despite the level of effort contemplated by this alternative, contaminant sources would remain due to the extensive and ubiquitous nature of floodplain and riverbed contamination. Over 9,000 acres of metals-enriched floodplain, approximately twice the area that would be excavated under this alternative, would not be excavated and would remain a source of hazardous substances to surface water and bed sediments of the Clark Fork River. Riverbed sediments between Warm Springs and Milltown Reservoir would remain contaminated and would continue to receive contamination from floodplain areas, thereby continuing to expose and contaminate benthic macroinvertebrates and surface water. Riverbanks that are not removed would also remain a source of hazardous substances. Releases from Warm Springs Ponds would continue. Given the residual floodplain and riverbed contamination under this alternative, natural resources and services would not be restored to baseline conditions for thousands of years, the time required for natural processes to remove remaining contamination from the Clark Fork River and its floodplain.

9.5.3 Alternative 9B

This alternative removes less floodplain and riverbank contamination than Alternative 9A while restoring riparian resources. The key elements of this alternative include:

- 1) excavating 2,250 acres of tailings and related floodplain contamination;
- 2) disposing of excavated materials at Anaconda and/or Opportunity Ponds;
- 3) partial backfilling of excavated floodplain areas;
- 4) revegetating excavated floodplain areas;
- 5) removing, reconstructing, and stabilizing riverbanks between Warm Springs Ponds and Deer Lodge;
- 6) management of grazing to allow vegetation to reestablish;
- 7) flow augmentation; and,
- 8) natural recovery.

Under this alternative, 2,250 acres of tailings and associated floodplain contamination containing approximately 1,702,000 cubic yards of material would be excavated.

Excavation would occur mainly between Warm Springs and Garrison. Following excavation, the floodplain would be partially backfilled, recontoured and revegetated with species of native grasses, shrubs, and trees. An area equal to the extent of riparian wildlife habitat injury (215 acres) would be replanted to reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. The remaining 2,035 acres of excavated floodplain would be revegetated to stabilize excavated areas and prevent erosion. Grazing would be managed for a short period of time to facilitate revegetation.

Like Alternative 9A, riverbanks between Warm Springs and Deer Lodge would be removed, reconstructed, and stabilized. Excavated floodplain tailings would be disposed of at the Anaconda and/or Opportunity Ponds. Flow augmentation would be utilized to address residual riverbed and surface water contamination.

Under this alternative, recovery and restoration of riparian resources would occur in the same time frame as under Alternative 9A. Specifically, substantial recovery would occur within 20 years as vegetation matures; restoration to baseline would occur in approximately 50 years.

Aquatic resource injuries would not be mitigated to the same extent under this

alternative as under Alternative 9A. This alternative removes 50% of the area of floodplain contamination and about 60% of the volume of contaminated floodplain material as is removed under Alternative 9A. Although significantly less floodplain material is removed than under Alternative 9A, proportionally more contamination is removed because this alternative addresses the most highly contaminated floodplain materials. The frequency and amount of loadings of hazardous substances to the River from surface runoff, and bankfull and overbank high flows, would be greater under this alternative than Alternative 9A. Still, this alternative would reduce contaminant concentrations relative to existing conditions, which would result in substantial recovery in trout populations, though not to the same levels as under Alternative 9A. Population levels would triple, or increase by 200% (but return to only about 50% of baseline) within 10 to 20 years.

Given the existence of significant floodplain, bank, and bed sediment contamination remaining under this alternative, resources and services would not be restored to baseline conditions for thousands of years, the amount of time that would be required for natural processes to remove hazardous substances from the Clark Fork River and its floodplain.

9.5.4 Alternative 9C

This alternative removes less floodplain and riverbank contamination than Alternative 9B while restoring riparian resources. The key elements of this alternative include:

- 1) excavating 1,125 acres of tailings and related floodplain contamination;
- 2) disposal of excavated materials at Anaconda or Opportunity Ponds;
- 3) partial backfilling of excavated floodplain areas;
- 4) revegetating excavated floodplain areas;
- 5) removing, reconstructing, and stabilizing riverbanks between Warm Springs Ponds and Deer Lodge;
- 6) management of grazing to allow vegetation to reestablish;
- 7) flow augmentation; and,
- 8) natural recovery.

Under this alternative, 1,125 acres of tailings and associated floodplain contamination containing approximately 1,158,000 cubic yards of material would be excavated. Excavation would occur mainly between Warm Springs and Deer Lodge. Following excavation, the

floodplain would be partially backfilled, recontoured and revegetated with species of native grasses, shrubs, and trees. An area equal to the extent of riparian wildlife habitat injury (215 acres) would be replanted to reflect a baseline habitat mix of shrub/forest and agricultural (hay/pasture) habitat types. The remaining 910 acres of excavated floodplain would be revegetated to stabilize excavated areas and prevent erosion. Grazing would be managed for a short period of time to facilitate revegetation.

Like Alternatives 9A and 9B, riverbanks between Warm Springs and Deer Lodge would be removed, reconstructed, and stabilized. Excavated floodplain tailings would be disposed of at the Anaconda or Opportunity Ponds. Flow augmentation would be utilized to address residual riverbed and surface water contamination.

Under this alternative, recovery and restoration of riparian resources would occur in the same time frame as under Alternatives 9A and 9B. Specifically, substantial recovery would occur within 20 years as vegetation matures; restoration to baseline would occur in approximately 50 years.

Aquatic resource injuries would not be mitigated to the same extent under this alternative as under Alternatives 9A and 9B. This alternative removes 25% of the area of floodplain contamination and about 40% the volume of contaminated floodplain material as occurs in Alternative 9A; and 50% and 60%, respectively, of contaminated floodplain area and volume of contaminated material as occurs in Alternative 9B. As in Alternative 9B, proportionally more contamination is removed than floodplain acreage addressed in Alternative 9B because this alternative addresses only the most contaminated 25% of floodplain contamination. The intensity and frequency of loadings of hazardous substances to the River from surface runoff, and bankfull and overbank high flows would be greater than in Alternatives 9A and 9B. Still, this alternative would reduce contaminant concentrations relative to existing conditions, which would result in substantial recovery in trout populations, though not to the same levels as under either Alternative 9A or 9B. Trout populations would double, or increase by 100% (returning to only about 35% of baseline) within approximately 10 to 20 years under this alternative, compared to quadrupling (returning to 70% of baseline) under Alternative 9A, and tripling (returning to 50% of baseline) under Alternative 9B.

Given the existence of significant floodplain, bank, and bed sediment contamination remaining under this alternative, resources and services would not be restored to baseline conditions for thousands of years, the amount of time that would be required for natural processes to remove hazardous substances from the Clark Fork River and its floodplain.

9.5.4 Alternative 9D

In this alternative, no further action is taken beyond the CERCLA response action. Four-hundred acres of devegetated or largely devegetated floodplain areas would have been treated by STARS to reduce runoff. Thousands of acres of contaminated floodplain would remain a source of hazardous substances to surface water. Bed and bank sediments would remain contaminated the entire length of the Clark Fork River. Releases of hazardous substances from Warm Springs Ponds would continue.

The STARS-remedy will partly restore wildlife habitat by revegetating with a few grass and shrub species. However, this action would not return riparian resources to a baseline condition. Concentrations of hazardous substances in STARS-treated areas will be phytotoxic to many species of native shrubs and grasses. Reestablishment of vegetation indicative of baseline will depend on natural erosional processes to remove contamination. This will occur over hundreds or even thousands of years.

The Clark Fork River would remain contaminated as long as extensive floodplain contamination exists and remains a source of hazardous substances to aquatic resources. Aquatic resources and services would not be restored for thousands of years, the amount of time required for erosion to remove floodplain contamination. Over time, however, recovery would occur as the amount of floodplain contamination decreases and the severity of impacts to aquatic resources lessens.

It is difficult to estimate the time that would be required to achieve any of the levels of substantial recovery that would occur under Alternatives 9A, 9B and 9C. While removal of sources of contamination to the Clark Fork River, as occurs under the alternatives, would achieve increases in fish populations in a matter of a decade or two, similar increases in fish populations would take hundreds, if not thousands, of years of natural processes to achieve.

9.6 Evaluation of Alternatives

9.6.1 Technical Feasibility

Alternatives 9A, 9B, 9C, and 9D are equivalent in terms of technical feasibility. Alternative 9D, which calls for monitoring and natural recovery, is technically feasible. With respect to the other three alternatives, the alternatives equally employ well-known and accepted technologies and have a reasonable chance of successful completion in an acceptable period of time. The alternatives are all variations on a theme: removal of tailings and contaminated soils. Excavation of tailings and contaminated soils should not be difficult, will eliminate a source of contamination to the Clark Fork River, and is currently under consideration at several locations in the Upper Clark Fork Basin.

9.6.2 Cost-effectiveness

A distinction between the alternatives cannot be made on cost-effectiveness grounds because the alternatives produce different benefits. Under Alternative 9A populations of fish in the Clark Fork River would go from 17 percent of baseline to 70 percent of baseline within two decades. Under Alternative 9B populations of fish in the Clark Fork River would return to 50 percent of baseline within two decades. Under Alternative 9C populations of fish would return to 35 percent of baseline within two decades. Under Alternative 9D populations of fish would remain at about their present level--17 percent of baseline-- for the foreseeable future.

9.6.3 Results of Response Actions

Response actions anticipated to occur at the Clark Fork River will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

STARS is projected to occur under remedy at this site. Accordingly, implementation of the alternatives must be coordinated with remedy. This plan assumes such coordination will occur. Should it become evident that coordination is not possible, this plan will be revised accordingly.



9.6.4 Potential for Additional Injury

There will be significant short-term environmental impacts from the implementation of Alternatives 9A and 9B. As between these two alternatives, impacts will be significantly greater under Alternative 9A than under Alternative 9B. There will also be impacts associated with Alternative 9C, but these impacts are expected to be relatively minor compared to the impacts associated with the other two action alternatives.

Short-term environmental impacts from the implementation of all the alternatives relate to runoff into surface water from floodplain disturbance and emissions of particulates from construction activities. Alternative 9B entails a significantly greater amount of floodplain excavation than Alternative 9C so impacts of this nature will obviously be greater under this alternative than under Alternative 9C. For the same reason, impacts will be greater under Alternative 9A than Alternative 9B. Standard practices will be used to ameliorate these impacts. Since Alternative 9D calls for no floodplain excavation, these impacts will not exist.

Of more significance regarding the issue of impacts are concerns about the condition of the floodplain that is to be excavated. Alternative 9C, which entails floodplain excavation mainly between Warm Springs and Deer Lodge, will principally occur over lands that are devegetated and poorly vegetated. Proceeding downstream, the quality of floodplain vegetation improves. Thus, Alternative 9B, which calls for floodplain excavation mainly between Warm Springs and Garrison, will require the disturbance of areas higher in vegetative quality than would be disturbed under Alternative 9C. Similarly, Alternative 9A, which calls for excavation mainly between Warm Springs and Drummond, will require the disturbance of areas higher in vegetative quality than would be disturbed under Alternative 9B. Given the large number of acres proposed to be excavated under Alternatives 9A and 9B, a significant amount of relatively well vegetated land would need to be disturbed.

9.6.5 Natural Recovery and the Ability of the Resource to Recover

Under all of the alternatives restoration to baseline is not projected to occur for thousands of years. The amount of contamination in the floodplain is so great, it will take this long for natural processes to remove all the sources.

Still, removal of floodplain contamination can provide substantial benefits to the resources. As noted above, under Alternative 9A, fish populations would return to 70 percent of baseline within two decades. Alternatives B and C would produce, in the same amount of time, recovery to baseline of 50 percent and 35 percent, respectively.

9.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Risks to human health and safety, to the extent such risks exist, will be minimized by compliance with all applicable laws and regulations governing workplace safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected. Since Alternative 9A is the most intensive it would presumably have the greatest degree of risk associated with it. Under this same reasoning Alternative 9D would pose the least amount of risk to human health and safety.

9.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

9.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. A mechanism to obtain water for in-stream purposes would have to be developed. The Montana legislature is currently considering proposals for in-stream flows, including the development of a pilot program to allow water to be leased for in-stream purposes. Before implementing the alternatives, the State would obtain all necessary permits and authorizations, including permission from landowners to conduct activities on their land.

9.6.9 Other Relevant Factors

At this time the State has identified no additional relevant factors.

9.6.10 Cost-Benefit/Decisionmaking Analysis

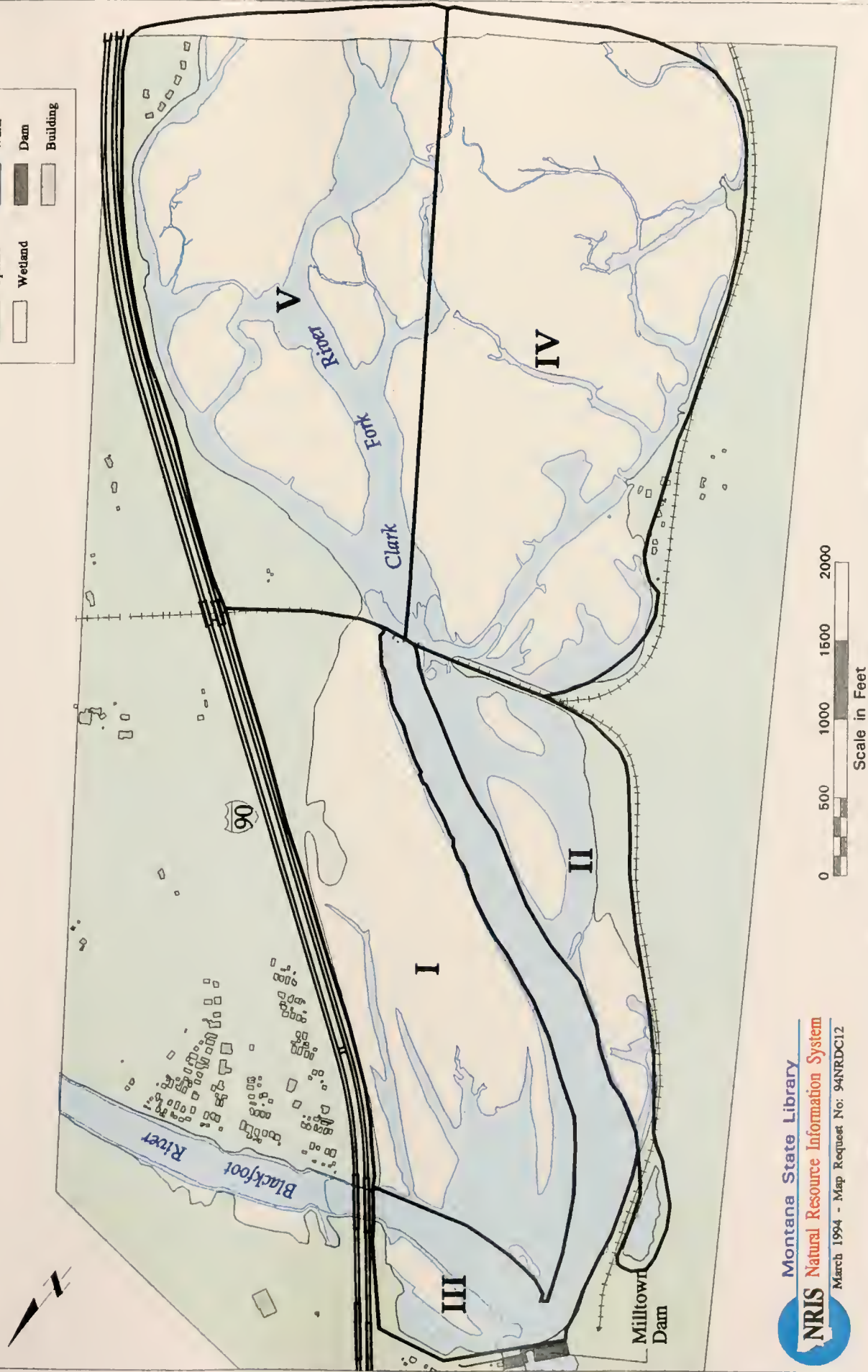
The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 9A--\$82.3 million; Alternative 9B--\$52.4 million; Alternative 9C--\$37.2 million; and Alternative 9D--\$5.6 million. Based on the following analysis, and informed by the previous discussion and the State's knowledge of the resource, the State selects Alternative 9A.

The Clark Fork River is a severely injured resource, which could be of great value to the State of Montana. Restoration alternatives exist that would significantly improve the condition of the resource over its presently depressed condition. Moreover, a failure by the State to act to restore this resource would result in the condition of the resource being made virtually permanent.

Accordingly, the State determined that Alternative 9A would come the closest to the State's objective of enabling the Clark Fork River to be a relatively healthy, productive system. Neither Alternative 9B or 9C accomplished enough in the way of recovery to justify the expenditure of tens of million of dollars. Alternative 9A, on the other hand, produced a recovery to 70 percent of baseline. The greater cost of this alternative was justified by the significant benefits it produced.

Finally, Alternative 9A was preferred notwithstanding the environmental impacts from excavating 4,500 acres of floodplain. The floodplain will recover, but without removing the source of contamination the Clark Fork River, in essence, would not recover.

Figure 10-1. Milltown Reservoir Sediment Unit Boundaries



10.0 MILLTOWN GROUNDWATER RESOURCES

10.1 Description of Site and Injury

Milltown Dam was constructed in 1907-1908 at the confluence of the Clark Fork and Blackfoot Rivers, forming Milltown Reservoir. The dam is approximately 124 miles downstream from the Clark Fork River's headwaters near Warm Springs Ponds. The Reservoir is part of the Milltown Reservoir/Clark Fork River NPL site.

Approximately 6.6 million cubic yards of contaminated sediments have been deposited in the reservoir as a result of the downstream transport of mining, milling, and smelting wastes from the Butte and Anaconda areas. Consequently, the reservoir's storage capacity has been largely depleted. It is estimated that almost 80% of the sediment load currently carried by the Clark Fork River (approximately 43,000 cubic yards per year) and the Blackfoot River (32,000 cubic yards per year) passes through the reservoir to the Clark Fork River downstream of Milltown Dam. At present, the reservoir covers approximately 180 acres and has a storage capacity of about 800 acre-feet.

Reservoir sediments contain concentrations of hazardous substances and associated contaminants significantly greater than baseline. Concentrations of arsenic, the primary hazardous substance of concern, are 30 times baseline. Hazardous and deleterious substances released from these sediments have contaminated the groundwater underlying and adjacent to the Milltown Reservoir. In November 1981, community wells at Milltown were found to contain groundwater with arsenic concentrations as much as ten times the drinking water standard.

The groundwater system at Milltown is comprised of the groundwater in saturated reservoir sediments and the underlying alluvial material. Reservoir sediments are comprised of fine-grained sand, silt, and clay and range in thickness from as much as 29 feet immediately behind the dam to a few feet at the upstream end of the impoundment. In general, sediments thin in an upstream direction. These sediments overlie the original coarse alluvial floodplain material. The thickness of the alluvium underlying the reservoir sediments is unknown. Just north of the reservoir the alluvium is 30 feet thick, extending to 160 feet thick near the town of Milltown. The water table in the reservoir sediments is

typically 10 to 15 feet higher than the water table beneath the town of Milltown. Reservoir water saturates the exposed and submerged fine-grained reservoir sediments and flows towards the town of Milltown by moving both northward and downward into the underlying coarse alluvium. The groundwater then trends to the northwest and down the Clark Fork River Canyon.

Groundwater injury has been demonstrated by the presence of arsenic, iron, and manganese at concentrations that exceed primary (arsenic) and secondary (iron and manganese) drinking water standards. Arsenic concentrations are 20 times the drinking water standard. The areal extent of the arsenic plume is approximately 110 acres; slightly more than one-fifth of the plume extends beyond the boundaries of the reservoir. The areal extent of both the iron and manganese plumes are greater than the extent of the arsenic plume. Based on the manganese plume, which is the largest contaminant plume, the volume of contaminated groundwater is between approximately 5,100 and 7,890 acre-feet. The annual flux of contaminated groundwater is estimated to be 16,910 acre-feet per year for arsenic; 31,540 acre-feet per year for iron, and 110,990 acre-feet per year for manganese.

10.2 Sources of Hazardous Substances

The source of groundwater contamination is the fine-grained contaminated sediments in Milltown Reservoir. Contaminants are released as water flows through the sediments. Groundwater carries contaminants from the reservoir sediments to the underlying sand, gravel, and cobble alluvial aquifer.

The Milltown Reservoir Sediments Draft Site Remedial Investigation delineated five sediment accumulation areas. These areas differ in sediment thickness, the amount of sediment arsenic contamination, and arsenic concentrations in sediment porewater or groundwater.

Three adjacent deposition areas (areas I, II, and III) are generally contiguous with the extent of arsenic, iron and manganese plumes and therefore represent a significant source of groundwater contamination. Area I contains approximately 2,640,000 cubic yards of sediments and is located between the River and the interstate highway north of the Reservoir. This area contains the most contaminated reservoir sediments (319 mg/kg of arsenic) and the highest concentrations of arsenic in sediment porewater (2.43 mg/l). Area II contains

approximately 760,000 cubic yards of sediments and is located south of the river channel. This area contains the lowest porewater concentrations of arsenic of any of the five sediment areas. Area III contains approximately 480,000 cubic yards of sediments. It is coextensive with the Clark Fork River channel. Of the three areas, Area III contains the lowest concentrations of arsenic in sediments but, like Area I, contains porewater concentrations of arsenic (.063 mg/l) above drinking water standards. Together these areas contain approximately 3,880,000 cubic yards of sediments, about sixty percent of the total amount of sediments in Milltown Reservoir.

Two other sediment deposition areas are located upstream of the main contaminant plumes. These areas (IV and V) contain approximately 1,200,000 and 1,520,000 cubic yards, respectively, of contaminated sediments. These sediments range from two to twelve feet in thickness. As indicated by porewater arsenic concentrations and the absence of contaminant plumes, these sediments appear to contribute much less to the overall groundwater injury in the alluvium and sediments downstream than the sediments in areas I, II, and III. However, arsenic concentrations in sediments in Areas IV and V, while not as high as in Area I, are substantially greater than in Areas II and III.

Releases of contaminants from reservoir sediments are believed to result from two geochemical processes. One mechanism is the reduction of oxide minerals in the lower 15 to 20 feet of sediments. Another mechanism is the alternating oxidation and reduction of sulfide minerals in the upper 2 to 10 feet of sediments. The second process has been referred to as a "redox pump" because it is associated with alternating oxidizing and reducing conditions caused by fluctuating water levels in the reservoir. Montana Power Company's current operating license for the hydroelectric project limits the amount of water level fluctuation in the reservoir to a maximum of two feet in order to control releases from the "redox pump" process. Under normal operating conditions, water level generally fluctuates less than one foot.

1.3 CERCLA Response Action

Response actions to date consist of the construction of a new public water supply system for the town of Milltown. This work was completed in 1985.

The Remedial Investigation/Feasibility Study (RI/FS) for Milltown Reservoir is in

progress. The primary issues are remediation of groundwater contamination and potential releases of hazardous substances to the Clark Fork River downstream. A Record of Decision selecting the remedy is anticipated in 1996. However, based on a review of the RI/FS literature, an evaluation of actions implemented and planned at other sites in the Basin, consideration of ARCO's projection of remedy, and discussions with EPA and MDHES, it is estimated that the following actions will be implemented at Milltown Reservoir:

- 1) institutional controls, such as well drilling restrictions, to prevent use of contaminated groundwater.

10.4 Residual Injury

The remedy will not return injured resources to baseline, nor is it intended to. After implementation of the remedy, contaminated sediments will remain in Milltown Reservoir and will continue releasing hazardous substances to groundwater. Groundwater will remain contaminated, in the same amount and to the same extent, as it is at present. Thus, arsenic, iron, and manganese will remain at levels above drinking water standards and baseline conditions.

10.5 Restoration Alternatives

10.5.1 Introduction

The presence and continual accumulation of hazardous substances, the natural geochemical process releasing arsenic and metals, and the reservoir driven groundwater flow system influence the choice of restoration alternatives. Site characteristics limit the kinds of techniques that may be practically applied to restore groundwater. For example, the high groundwater velocities in the aquifer make pumping and treating, at a minimum, extremely difficult. Treatment of the largest contaminant plume (manganese) would require an extraction system and treatment facility capable of handling a minimum of 153 cubic feet per second (cfs) of groundwater, a flow equal to roughly one-third the August flow of the Clark Fork River above Milltown Reservoir. Targeting the arsenic plume alone would require facilities to collect and treat 23 cfs of groundwater. The design and construction of a groundwater extraction system and metals treatment facility for this volume of water would be an extremely difficult undertaking. Further, such a system, by itself, would not restore

groundwater--it would merely treat the contaminated groundwater leaving the system at Milltown. Nor would such a treatment system accelerate the timeframe to restoration.

Engineering efforts to limit or decrease the size of the contaminant plumes would be similarly difficult. Installation of an impermeable subsurface containment structure, such as a grout curtain or sheet piling, near or at the downgradient end of the contaminant plume might be considered. Given the large volume of water moving through the aquifer, the effectiveness of such an action would be highly uncertain. Even if such a barrier could be constructed, contaminated groundwater could be forced up through the reservoir sediments and into the Clark Fork River as a result of subsurface containment. If this were to occur, surface water and aquatic life downstream could be adversely affected.

Therefore, restoration of groundwater largely depends on source removal. Two issues relating to source removal are important in the design of restoration alternatives. First, disturbing the sediments creates the potential for releases of hazardous substances to surface water and/or groundwater. Physical disturbance of sediments can destabilize the geochemical environment under which reservoir sediments exist. This could remobilize hazardous substances and degrade surface water or groundwater. Alternatives that consider sediment removal address potential releases to groundwater by engineering techniques that dewater sediments prior to excavation. Potential releases to surface water could occur under any removal scenario, with adverse impacts to surface water and fish populations downstream.

The second issue related to source removal is that assuming the continued existence of Milltown Dam and the reservoir, resedimentation will occur in those reservoir areas excavated to remove sediments. Reservoir sediments that are left in place, and sediments in the Clark Fork River drainage upstream, will redeposit in the reservoir. Although redeposited sediments will be less contaminated than the excavated sediments, and the condition of the resource will significantly improve relative to its present condition, the potential for recontamination of the alluvial aquifer is relatively high. Therefore, alternatives are designed to address resedimentation of Milltown Reservoir.

10.5.2 Alternative 10A

This alternative would remove all contaminated sediments from Milltown Reservoir to eliminate releases of hazardous and deleterious substances to groundwater. Milltown Dam would be removed. The key elements of this alternative are:

- 1) constructing a levee to isolate excavation sites from the Clark Fork River;
- 2) constructing a system of trenches and pumps to dewater reservoir sediments;
- 3) constructing a treatment plant to treat water removed from reservoir sediments;
- 4) excavating reservoir sediments;
- 5) disposing of excavated sediments at a constructed repository;
- 6) removal of Milltown Dam; and
- 7) natural recovery.

This alternative contemplates complete removal of 6,600,000 cubic yards of contaminated reservoir sediments. A levee would first be constructed in the reservoir to direct the flow of the Clark Fork River to one side of the reservoir. The sediments on the other side of the levee would be dewatered using a system of trenches and pumps similar to common gravel mining operations. The pumped water would be treated and discharged to the river. Excavation would proceed such that the dewatering would not exceed 1,000 gpm. The contaminated sediment would then be excavated in the "dry." Following excavation of one side, the levee would be removed and reconstructed to excavate the remaining sediments, including those that were beneath the levee at its first location. Excavated materials would be disposed of at a constructed repository nearby. Following removal of sediments Milltown Dam would be removed. Wetlands within the reservoir that are removed during excavation would return over time as the reexposed Clark Fork River channel naturally recovers. However, the area of wetlands would likely be substantially less than now exists within the reservoir.

Despite the level of effort contemplated by this alternative, it is unlikely that one hundred percent of the contaminated sediment would be removed. Some amount of contaminated sediment would likely remain within and on top of the underlying coarse-

grained alluvial floodplain. Immediately following sediment excavation, contaminant concentrations in groundwater would decrease markedly. Drinking water standards could be achieved throughout the injured alluvial aquifer in a period of several months following removal. Groundwater could be restored to baseline in two or three years.

The removal of Milltown Dam would eliminate the site conditions that have resulted in groundwater injury (a large volume of highly contaminated wastes emplaced on top of a highly permeable alluvial aquifer, geochemical conditions within the reservoir sediments that resulted in contaminant releases, and the reservoir-driven groundwater system that drives contaminants to the adjacent and underlying alluvial aquifer). With Milltown Dam removed, there is no potential for contaminated sediments migrating from the upper Clark Fork River drainage to deposit behind the Dam. These sediments would pass through the site to the Clark Fork River downstream (which is largely the situation occurring at the present time). The potential for reinjury and/or recontamination due to redeposition of contaminated sediments would be eliminated.

10.5.3 Alternative 10B

This alternative would remove all contaminated sediments from Milltown Reservoir to eliminate releases of hazardous and associated substances to groundwater. Milltown Dam would be left in place. The key elements of this alternative are:

- 1) constructing a levee to isolate excavation sites from the Clark Fork River;
- 2) constructing a system of trenches and pumps to dewater reservoir sediments;
- 3) constructing a treatment plant to treat water removed from reservoir sediments;
- 4) excavating reservoir sediments;
- 5) disposing of excavated sediments at a constructed repository;
- 6) periodic reexcavation of redeposited sediments; and
- 7) natural recovery

This alternative contemplates complete removal of 6,600,000 cubic yards of contaminated reservoir sediments. Removal would proceed as under Alternative 10A, by construction of a levee and other infrastructure to dewater, excavate, and dispose of reservoir sediments. As under Alternative 10A, sediments would be disposed of at a repository

constructed nearby. Wetlands within the reservoir that are removed during excavation would return over time as sediment redeposition creates conditions favorable for their development.

Despite the level of effort contemplated by this alternative, it is unlikely that one hundred percent of the contaminated sediment would be removed. Some amount of contaminated sediments would likely remain within and on top of the underlying coarse grained alluvial floodplain. Notwithstanding the very limited amount of contamination remaining and the immediate reoccurrence of sediment redeposition, the high permeability of reservoir sediments and underlying floodplain alluvium, coupled with the large volume of groundwater flowing through the area, will create favorable conditions whereby groundwater has substantially recovered, at least in the near-term. Immediately following sediment excavation, contaminant concentrations in groundwater would decrease markedly. Drinking water standards could be achieved in a period of several months following removal.

As noted, immediately following excavation redeposition will begin. Based on recent studies, approximately 75,000 cubic yards of sediment presently enter the reservoir system. Thus, the existing volume of reservoir sediments (6.6 million cubic yards) could be replaced in about 90 years. Over time, as the reservoir filled in, groundwater quality would slowly degrade. The severity of contamination would likely be less than presently exists because redeposited sediments would be less contaminated than those excavated. However, redeposited contaminated sediments would threaten recovery to drinking water standards. Therefore, this alternative proposes a one-time reexcavation of reservoir sediments in 90 years to address sediment redeposition and the likelihood of groundwater recontamination.

Similarly, redeposition will prevent groundwater from returning to baseline in the same length of time as under Alternative 10A. In the century following reexcavation, the reservoir will again fill in. In the end, natural recovery will be required to remove residual contamination from the Milltown Reservoir. Baseline might not be achieved for centuries, but in any event, the time to baseline would be less than it would be in the reservoir's present condition.

10.5.4 Alternative 10C

This alternative would remove sediments from source areas in Milltown Reservoir to reduce releases of hazardous and associated substances to groundwater. The key elements of this alternative are:

- 1) constructing a levee to isolate excavation sites from the Clark Fork River;
- 2) constructing a system of trenches and pumps to dewater reservoir sediments;
- 3) constructing a treatment plant to treat water removed from reservoir sediments;
- 4) excavating reservoir sediments in Areas I, II and III;
- 5) disposing of excavated sediments at a constructed repository;
- 6) periodic reexcavation of redeposited sediments; and
- 7) natural recovery.

This alternative contemplates complete removal of 3,880,000 cubic yards of contaminated reservoir sediments left in place by the remedy. Sediments would be excavated from those areas (areas I, II, and III) that are generally contiguous with the extent of the arsenic, iron and manganese plumes. Removal would proceed as under Alternative 10A, by construction of a levee and other infrastructure to dewater, excavate, and dispose of reservoir sediments. As under Alternative 10A, sediments would be disposed of at a repository constructed nearby. Wetlands within the reservoir that are removed during excavation would return over time as sediment redeposition creates conditions favorable for their development.

Despite the level of effort contemplated by this alternative a large volume of contaminated sediment (2,272,000 cubic yards) would remain in Areas IV and V, in addition to the contaminated sediment that would remain within and on top of the underlying coarse grained alluvial floodplain in Areas I, II and III. Notwithstanding this substantial amount of remaining contamination, the high permeability of reservoir sediments and underlying floodplain alluvium, coupled with the large volume of groundwater flowing through the area, will create favorable conditions whereby groundwater has substantially recovered. Within several months following sediment excavation, contaminant concentrations in groundwater would decrease markedly. Drinking water standards could be

achieved in several years following removal.

As under Alternative 10B, excavated areas will begin filling in as sediments in the Clark Fork River and reservoir sediments in Areas IV and V migrate downstream. It is estimated that excavated areas would fill in about 50 years (compared to 100 years in Alternative 10A) because the volume of excavated sediments is substantially less than in Alternative 10B, and a greater volume of sediments will remain in place adjacent to the excavated area. Over time, groundwater quality would slowly degrade as the reservoir filled in. Compared to Alternative 10B, there is a greater risk of groundwater recontamination due to sediment redeposition because redeposited sediments will be more contaminated than those under Alternative 10B. Because redeposited sediments would threaten recovery to drinking water standards, this alternative proposes two reexcavations of reservoir sediments (in 50 and 100 years) to address sediment redeposition and the likelihood of groundwater recontamination.

Similarly, redeposition will prevent groundwater from returning to baseline in the same length of time as under Alternative 10B. After the final removal action, the reservoir will again fill in. In the end, natural recovery will be required to remove residual contamination from the Milltown Reservoir. Although baseline might not be achieved for centuries, the time to baseline would be less than the time to baseline given the present condition of the reservoir, but greater than in Alternative 10B due to the greater degree of contamination associated with redeposited sediments.

10.5.6 Alternative 10D

Under this alternative, no further action is taken at the site beyond CERCLA response actions. Groundwater will remain injured until natural processes remove contaminants from reservoir sediments through the groundwater system.

The amount of contamination within the reservoir sediments has been calculated for arsenic (2100 tons), iron (143,900 tons) and manganese (9200 tons). Assuming that the natural flux of contaminants out of reservoir sediments remains at its present level, iron contamination would be depleted in approximately 220 years (approximately 3,550 pounds per day are removed from the system). However, contaminant flux will not remain constant over time but will decrease as sediment contamination decreases. Natural recovery of

injured groundwater to baseline conditions will occur over hundreds to thousands of years.

10.6 Evaluation of Alternatives

10.6.1 Technical Feasibility

All the action alternatives target sediment removal. All are technically feasible in this regard. In other words, all of the alternatives will be able to accomplish this task through the application of standard construction techniques such as the construction of dikes for dewatering purposes.

Dam removal as proposed by Alternative 10A is technically feasible. The dam is not large, is old, and may not be particularly stable. Removal should present no technical problems. There may be a difference between the alternatives with regard to whether the alternatives have a reasonable chance of being successfully completed. Differences between the alternatives may exist due to issues related to resedimentation of the reservoir after excavation. This is not an issue for Alternative 10A because there is no dam and reservoir with this alternative. Alternatives 10B and 10C, acknowledge that resedimentation may occur. Both alternatives call for reexcavation in a number of years in the event of recontamination. Alternative 10B proposes a one-time reexcavation in year 90. Alternative 10C proposes to reexcavate twice, at years 50 and 100. While it is uncertain if recontamination of groundwater will occur with resedimentation, the flip side is also true. That is, it is uncertain whether the groundwater will again become contaminated even after the reservoir has been reexcavated once or twice.

10.6.2 Cost-effectiveness

Distinctions between the alternatives cannot be made on cost-effectiveness grounds because they produce different levels of benefits. Removal of all the reservoir sediments and the removal of the dam as proposed by Alternative 10A will result in restoration to baseline within two or three years and a return to drinking water standards in a few months. Under Alternative 10B removal of all reservoir sediments would result in a return to drinking water standards in several months. With the dam in place, however, the reservoir will slowly begin to fill back in and groundwater quality will likely slowly degrade. Leaving the dam in place necessitates reexcavation and will lengthen the time for restoration to baseline. Only a

portion of the reservoir sediments are removed under Alternative 10C and the dam is left in place. This results in an increase in the time required to return to drinking water standards over the other alternatives, an increase in the time for restoration to baseline, and necessitates allowing for the possibility for two reexcavations.

10.6.3 Results of Response Actions

The response actions that have occurred and are anticipated to occur at Milltown will not restore injured resources and will leave significant residual injury. The restoration alternatives were designed to address the residual injury and to improve the condition of injured resources.

10.6.4 Potential for Additional Injury

There is a potential for significant environmental impacts associated with removing Milltown reservoir sediments. Since all the action alternatives share this element, the significance of the risk is roughly equivalent as between them, and does not apply at all to Alternative 10D. Specifically, disturbance of the highly contaminated sediments in the reservoir could remobilize hazardous substances and cause significant loadings of metals to groundwater and to the Clark Fork River. Although the alternatives would be designed to minimize releases of hazardous substances, it appears that some degree of release would occur. What is uncertain is the relative severity of such a release.

Sediment excavation under the alternatives will result in the elimination of wetlands that have developed in the reservoir. Although some amount of wetlands will naturally return after implementation of any of the alternatives, the disturbance of the wetlands in the reservoir will adversely impact biological resources that have come to depend on the wetlands.

Environmental impacts will also exist due to the need to construct a disposal facility for the sediments. Related impacts include vehicle emissions from hauling the sediment to the repository, which is projected to be within 10 miles of the site.

10.6.5 Natural Recovery and the Ability of the Resource to Recover

The high groundwater flux rate at Milltown creates relatively favorable conditions for recovery given the presence of over 6 million cubic yards of highly contaminated sediment. Still, natural recovery under Alternative 10D is projected to take hundreds to thousands of years. As discussed above, removal of sediments could significantly shorten the time it would take to reach drinking water standards and to reach baseline.

10.6.6 Human Health and Safety

There is virtually no difference between the alternatives with regard to this factor. Risks to human health and safety, to the extent such risks exist, will be minimized by compliance with all applicable laws and regulations governing workplace safety and by designing and implementing the alternatives in such a manner as to ensure that the public is protected. Since Alternative 10A is the most intensive it would presumably have the greatest degree of risk associated with it. Under this same reasoning Alternative 10D would pose the least amount of risk to human health and safety.

10.6.7 Federal, State, and Tribal Policies

There are no federal, state, or tribal policies implicated by these alternatives.

10.6.8 Federal, State, and Tribal Laws

All alternatives are consistent with applicable law. Dam removal of the Milltown dam would require the approval of the Federal Energy Regulatory Commission, which licenses the Montana Power Company hydroelectric project at the site. Before implementing the alternatives, the State would obtain all necessary permits and authorizations.

10.6.9 Other Relevant Factors

Removal of the Milltown dam might benefit the trout fishery in the Clark Fork River. In making this determination, however, it would be necessary to evaluate the value of the dam as a barrier to non-native species. Removal of the dam might also alleviate any safety concerns associated with the structure. It is unclear what position Montana Power Company would take on the subject of dam removal. Finally, the Milltown reservoir, although largely

filled in, still provides some recreational and public amenities that a river would not provide.

10.6.10 Cost-Benefit/Decisionmaking Analysis

The costs of the alternatives, which are displayed on the cost sheets contained in the Appendix, are as follows: Alternative 10A--\$109.3 million; Alternative 10B--\$109.8 million; Alternative 10C--\$86.5 million; and Alternative 10D--\$.3 million. Based on the following analysis, and informed by the previous discussion and the State's knowledge of the resource, the State selects Alternative 10D.

The State's decision to select Alternative 10D was based on the relatively high costs of the action alternatives considering the degree of environmental associated with implementing the alternatives. At present, the State is not assured that releases of hazardous substances can be sufficiently controlled.

Uncertainties associated with gaining approval for dam removal and the uncertainties with respect to recontamination of the reservoir also militated against the selection of one of the action alternatives. A more favorable assessment of the prospects for dam removal might have produced a different outcome. Similarly, greater assurance on the subject of recontamination might have lead to a selection of either Alternative 10B or 10C.

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APPENDIX A

DETAILED COST ESTIMATES

INTRODUCTION

The following tables display cost estimates for each alternative listed in the plan. Explanatory notes follow each table.

Costs were estimated for the foregoing alternatives by utilizing the cost estimating methodologies identified in the DOI regulations. Among the methodologies utilized to derive cost estimates are: 1) comparison methodology (43 CFR §11.83(b)(2)(i)), 2) unit methodology (43 CFR §11.83(b)(2)(ii)), and 3) standard time data methodology (43 CFR §11.83(b)(2)(v)).

In particular, estimates were derived from the following general sources:

- 1) actual unit costs for work in the Basin;
- 2) actual market prices;
- 3) estimated unit costs for work in the Basin after verification for reasonableness;
- 4) actual unit costs for work outside the Basin;
- 5) unit costs for similar construction activities reported in the literature or vender quotes;
- 6) the 1994 Means Cost Guide for site work and landscaping.

The tables contain six columns. The description column identifies the particular work item to be costed. The next column breaks the work item into units and identifies the quantity of work to be undertaken per year. The third column is the unit cost. Next, the cost of the work item in 1994 dollars is displayed.

The fifth column identifies the years that work would occur. Year one is 1995, the year of the plan's issuance. Work is assumed to begin no sooner than the year after the issuance of the pertinent Record of Decision (ROD) due to the intention of the Natural Resource Damage Litigation Program that remedy and restoration be coordinated. However, work will not always begin the year after the ROD. In some cases, work will be phased in order to take into account other remediation or restoration actions at the site or elsewhere in the Basin. The length of time to implement a particular item is based on what is reasonable under the circumstances.

The final column identifies the present worth of the work item based on a discount rate of seven percent as established in the DOI regulations. 43 CFR §11.84(e)(2). No work

item extends beyond 50 years because application of the discount rate past that point produces insignificant increases in present worth.

The tables also display costs for contingencies and engineering and administration. Contingency costs, calculated at twenty percent of the alternative's present worth, simply reflect the uncertainty inherent in any cost estimate. Past practice has demonstrated that cost estimates of this nature are usually low. Typically, a greater volume of materials will need to be removed than originally anticipated and difficulties will arise during the operation. A value of twenty percent of the overall cost for contingencies is standard practice.

Engineering and administration costs, calculated at fifteen percent of the alternative's present worth, reflect costs of design, engineering, administration, and construction oversight. The fifteen percent figure is typical for construction of this nature.

All alternatives also include costs for monitoring. Monitoring would begin in year one and would serve two purposes--it would assist in restoration planning for those restoration actions that have not yet begun and it would track the condition of the resource into the future.

BUTTE HILL
ALTERNATIVE 2A

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1993 DOLLARS	COST YEARS	PRESENT WORTH @ 7%	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
CONSTRUCT RESERVOIR	25.560 AF	\$1.500 AF	\$38,340.000	0	\$38,340.000	
LEASE WATER TO OPERATE RESERVOIR	11.276 AF	\$42.00 AF	\$473.590	1-29	\$5,815.000	
SUBTOTAL					\$44,155.000	
STATE OVERSIGHT OF MONITORING DATA	1 YR	\$90.000 YR	\$90.000	1-50	\$1,242.000	
					\$1,242.000	
CONTINGENCY @ 20%		20%			\$9,079.000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$6,510.000	
TOTAL COST: ALTERNATIVE 2A						\$61,286.000

1 YEAR ZERO IS 1994

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BUTTE HILL - ALTERNATIVE 2A

- 1) Reservoir construction costs \$1,500 per acre foot. Leasing water to operate reservoir costs \$42 per acre foot.
- 2) No restoration is accomplished under this alternative. State oversight and monitoring assesses recovery of the resource. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and installation by outside consultants and laboratory costs. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

BUTTE HILL
ALTERNATIVE 2C

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1990 DOLLARS	COST YEARS	PRESENT WORTH @ 7%	TOTAL COST OF ALTERNATIVE
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WORK ITEM DESCRIPTION

STATE OVERSIGHT OF MONITORING DATA	1 YR	\$90,000 YR	\$90,000	1-50	\$1,242,000	=====
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TOTAL COST: ALTERNATIVE 2B

\$1,242,000

1 YEAR ZERO IS 1994

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BUTTE HILL - ALTERNATIVE 2C

No restoration is accomplished under this alternative. State oversight and monitoring assesses recovery of the resource. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and installation by outside consultants and laboratory costs. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

AREA ONE
ALTERNATIVE 3A

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE BRW TAILINGS	240,000 CY	\$6.00 CY	\$1,440,000	6-10	\$4,210,000	
2) EXCAVATE PARROT TAILINGS						
EXCAVATE AND STOCKPILE OVERBURDEN	280,000 CY	\$6.00 CY	\$1,680,000	6-8	\$3,143,000	
EXCAVATE TAILINGS	95,000 CY	\$6.00 CY	\$570,000	6-8	\$1,067,000	
REMOVE CITY/COUNTY SHOP COMPLEX	1 LS	\$250,000 LS	\$250,000	8	\$146,000	
3) EXCAVATE MSD TALINGS						
EXCAVATE AND STOCKPILE OVERBURDEN	112,000 CY	\$6.00 CY	\$672,000	6	\$448,000	
EXCAVATE TAILINGS	115,500 CY	\$6.00 CY	\$693,000	6	\$462,000	
4) HAULING AND DISPOSAL @ PONDS						
BRW TAILINGS	240,000 CY	\$7.50 CY	\$1,800,000	6-10	\$5,262,000	
PARROT TAILINGS	95,000 CY	\$7.50 CY	\$712,500	6-8	\$1,333,000	
MSD TAILINGS	115,500 CY	\$7.50 CY	\$866,250	6	\$577,000	
5) BACKFILL EXCAVATED AREAS						
BACKFILL BRW AREA	240,000 CY	\$12.00 CY	\$2,880,000	6-10	\$8,419,000	
BACKFILL MSD AREA	115,500 CY	\$12.00 CY	\$1,386,000	6	\$924,000	
6) RECONSTRUCT CITY/COUNTY SHOP COMPLEX	1 LS	\$750,000 LS	\$750,000	9	\$408,000	
7) INSTALL INTERCEPTION TRENCH - MSD AND SILVER BOW CREEK	9,885 LF	\$200 LF	\$1,977,000	10	\$1,005,000	
8) EXPAND LIME PRECIPITATION TREATMENT						
EXPAND TREATMENT FACILITY (1.45 MGD)	1 LS	\$5,800,000 LS	\$5,800,000	10	\$2,948,000	
INSTALL DISCHARGE LINE	6,770 LF	\$12.00 LF	\$81,240	10	\$41,000	
TREATMENT PLANT O & M	1 YR	\$701,800 YR	\$701,800	11-50	\$4,756,000	
TREATMENT PLANT SLUDGE DISPOSAL	1 YR	\$1,213,215 YR	\$1,213,215	11-50	\$8,222,000	
SUBTOTAL					\$43,371,000	
MONITORING	1 YR	\$90,000 YR	\$90,000	6-50	\$873,000	
SUBTOTAL					\$873,000	
SUBTOTAL					\$44,244,000	
CONTINGENCY @ 20%		20%			\$8,849,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$6,637,000	
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TOTAL COST:ALTERNATIVE 3A						\$59,730,000

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AREA ONE - ALTERNATIVE 3A

Restoration actions would be coordinated with response actions under the Emergency Removal Action (ERA) at Lower Area One (LAO) and the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). Excavation of tailings at LAO will be completed in the year 1999. At that time, two years of groundwater data collection will begin for designing a groundwater management system (2000 - 2001). Design and implementation of the groundwater management system and the site reclamation plan is anticipated to occur over the following three years (2002 - 2004). Response actions under the ERA would be fully implemented in the year 2004. Response actions for stormwater runoff would occur under the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). The BPSOU ROD is anticipated in the year 1999. Completion of the BPSOU remedy is anticipated in the year 2004.

- 1) Excavation of the BRW tailings would begin in the year 2000, the year following completion of excavation at LAO under the ERA. Tailings excavation would occur over 5 years (2000 - 2004). The volume of excavated material is 1,200,000 cubic yards (CY). This is based on the 800,000 CY of tailings expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin).
- 2) Excavation of the Parrot Tailings would begin in 2000, the year following issuance of the BPSOU ROD. Excavation would include 285,000 CY of tailings (190,000 CY, expanded by 50%) and 840,000 CY of overburden. Excavation would occur over three years (2000 - 2002). The city-county shop complex would be removed to facilitate excavation of tailings.
- 3) Excavation of the Metro Storm Drain (MSD) tailings would occur in 2000, the year following the issuance of the BPSOU ROD. Excavation would include 115,500 CY of tailings (77,000 CY, expanded by 50%) and 112,000 CY of overburden.
- 4) Hauling and disposal costs are based on an average distance of 10 miles to the Anaconda and/or Opportunity Ponds. Costs for BRW tailings are based on the volume of excavated material (Item 1, 1,200,000 CY). Costs for the Parrot Tailings are based on the volume of excavated material (Item 2, 285,000 CY). Costs for the MSD tailings are based on the volume of material (Item 3, 115,500 CY). Hauling and disposal will occur in the same years as excavation.
- 5) Excavated areas will be backfilled and contoured. Stockpiled overburden will be used for backfilling the Parrot Tailings site. Consequently, no cost is added for this item. The excavated Butte Reduction Works and Metro Storm Drain sites will be backfilled with clean imported material. Backfill volumes are equivalent to the volumes excavated. Backfilling will occur in the same years as excavation.
- 6) The City-County Shop Complex would be reconstructed in the year 2003, the year following removal of the Parrot Tailings. This assumes that the Complex would be reconstructed at its existing location.
- 7) The groundwater interception trench would be constructed along the Metro Storm Drain and Silver Bow Creek from Harrison Avenue to the Colorado Tailings in the year 2004.
- 8) The treatment facility constructed under the LAO ERA would be expanded to treat 2.35 additional cfs (1.45 MGD) of groundwater. A discharge line 6770 feet long would transport treated water back to the headwaters of Silver Bow Creek (the confluence of the Metro Storm Drain and Blacktail Creek). Construction of the treatment facility is anticipated in the year 2004. Operation and maintenance (O & M) costs for the treatment facility include water quality monitoring, electricity, personnel, and periodic replacement of equipment. Sludge disposal costs are based solely on the volume of water treated under restoration (2.25 cfs).

- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

AREA ONE
ALTERNATIVE 3B

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE PARROT TAILINGS						
EXCAVATE AND STOCKPILE OVERBURDEN	280,000 CY	\$6.00 CY	\$1,680,000	6-8	\$3,143,000	
EXCAVATE TAILINGS	95,000 CY	\$6.00 CY	\$570,000	6-8	\$1,067,000	
2) EXCAVATE MSD TALINGS						
EXCAVATE AND STOCKPILE OVERBURDEN	112,000 CY	\$6.00 CY	\$672,000	6	\$448,000	
EXCAVATE TAILINGS	115,500 CY	\$6.00 CY	\$693,000	6	\$462,000	
3) HAULING AND DISPOSAL @ PONDS						
PARROT TAILINGS	95,000 CY	\$7.50 CY	\$712,500	6-8	\$1,333,000	
MSD TAILINGS	115,500 CY	\$7.50 CY	\$866,250	6	\$577,000	
4) BACKFILL EXCAVATED AREAS						
BACKFILL MSD AREA	115,500 CY	\$12.00 CY	\$1,386,000	6	\$924,000	
5) INSTALL INTERCEPTION TRENCH - MSD AND SILVER BOW CREEK	9,885 LF	\$200 LF	\$1,977,000	10	\$1,005,000	
6) EXPAND LIME PRECIPITATION TREATMENT						
EXPAND TREATMENT FACILITY (1.45 MGD)	1 LS	\$5,800,000 LS	\$5,800,000	10	\$2,948,000	
INSTALL DISCHARGE LINE	6,770 LF	\$12.00 LF	\$81,240	10	\$41,000	
TREATMENT PLANT O & M	1 YR	\$701,800 YR	\$701,800	11-50	\$4,756,000	
TREATMENT PLANT SLUDGE DISPOSAL	1 YR	\$1,213,215 YR	\$1,213,215	11-50	\$8,222,000	
SUBTOTAL					\$24,926,000	
MONITORING	1 YR	\$90,000 YR	\$90,000	6-50	\$873,000	
SUBTOTAL					\$873,000	
SUBTOTAL					\$25,799,000	
CONTINGENCY @ 20%		20%			\$5,160,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$3,870,000	

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TOTAL COST:ALTERNATIVE 3B

\$34,830,000

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AREA ONE - ALTERNATIVE 3B

Restoration actions would be coordinated with response actions under the Emergency Removal Action (ERA) at Lower Area One (LAO) and the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). Excavation of tailings at LAO will be completed in the year 1999. At that time, two years of groundwater data collection will begin for designing a groundwater management system (2000 - 2001). Design and implementation of the groundwater management system and the site reclamation plan is anticipated to occur over the following three years (2002 - 2004). Response actions under the ERA would be fully implemented in the year 2004. Response actions for stormwater runoff would occur under the Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD). The BPSOU ROD is anticipated in the year 1999. Completion of the BPSOU remedy is anticipated in the year 2004.

- 1) Excavation of the Parrot Tailings would begin in 2000, the year following issuance of the BPSOU ROD. Excavation would include 285,000 CY of tailings (190,000 CY, expanded by 50%) and 840,000 CY of overburden. Excavation would occur over three years (2000 - 2002). The city-county shop complex would be removed to facilitate excavation of tailings.
- 2) Excavation of the Metro Storm Drain (MSD) tailings would occur in 2000, the year following the issuance of the BPSOU ROD. Excavation would include 115,500 CY of tailings (77,000 CY, expanded by 50%) and 112,000 CY of overburden.
- 3) Hauling and disposal costs are based on an average distance of 10 miles to the Anaconda and/or Opportunity Ponds. Costs for BRW tailings are based on the volume of excavated material (Item 1, 1,200,000 CY). Costs for the Parrot Tailings are based on the volume of material (Item 2, 285,000 CY). Costs for the MSD tailings are based on the volume of material (Item 3, 115,500 CY). Hauling and disposal will occur in the same years as excavation.
- 4) Excavated areas will be backfilled to and contoured. Stockpiled overburden will be used for backfilling the Parrot Tailings site. Consequently, no cost is added for this item. The excavated Butte Reduction Works and Metro Storm Drain sites will be backfilled with clean imported material. Backfill volumes are equivalent to the volumes excavated. Backfilling will occur in the same years as excavation.
- 5) The groundwater interception trench would be constructed along the Metro Storm Drain and Silver Bow Creek from Harrison Avenue to the Colorado Tailings in the year 2004.
- 6) The treatment facility constructed under the LAO ERA would be expanded to treat 2.25 additional cfs (1.45 MGD) of groundwater. A discharge line 6770 feet long would transport treated water back to the headwaters of Silver Bow Creek (the confluence of the Metro Storm Drain and Blacktail Creek). Construction of the treatment facility is anticipated in the year 2004. Operation and maintenance (O & M) costs for the treatment facility include water quality monitoring, electricity, personnel, and periodic replacement of equipment. Sludge disposal costs are based solely on the volume of water treated under restoration (2.25 cfs).
- 7) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1 YR		\$90,000 YR	\$90,000	6-50	\$873,000	
TOTAL COST:ALTERNATIVE 3C							\$873,000

AREA ONE - ALTERNATIVE 3C

State oversight and monitoring assesses natural recovery of the resource. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

SILVER BOW CREEK REGION
ALTERNATIVE 4A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	655,770	CY	\$6.00	\$3,934,620	2-6	\$15,077,000	
2a) EXCAVATE STREAMBED	75,638	CY	\$6.00	\$453,825	11-14	\$781,000	
2b) CONSTRUCT BYPASS CHANNEL	29,832	FT	\$22.50	\$671,220	11-14	\$1,156,000	
3) HAULING AND DISPOSAL @ PONDS TAILINGS	849,600	CY	\$7.50	\$6,372,000	2-6	\$24,417,000	
SEDIMENTS	75,638	CY	\$7.50	\$567,281	11-14	\$977,000	
4) BACKFILL EXCAVATED FLOODPLAIN	163,943	CY	\$12.00	\$1,967,310	2-6	\$7,539,000	
5) TOPSOIL/GROWTH MEDIA COVER	180,855	CY	\$10.00	\$1,808,546	2-6	\$6,930,000	
6) REVEGETATE FLOODPLAIN							
SEED AND MULCH GRASSES/FORBS	112	AC	\$825	\$92,565	2-6	\$355,000	
HAND PLANT SHRUBS/TREES	37	AC	\$4,620	\$172,788	2-6	\$662,000	
7) RECONSTRUCT STREAM CHANNEL							
BACKFILL EXCAVATED STREAMBED	37,819	CY	\$12.00	\$453,825	11-14	\$781,000	
CONSTRUCT CHANNEL BEDFORMS	29,832	LF	\$4.00	\$119,328	11-14	\$205,000	
CONSTRUCT TYPE 2 STREAMBANKS	23,866	FT	\$8.00	\$190,925	11-14	\$329,000	
CONSTRUCT TYPE 3 STREAMBANKS	23,866	FT	\$51.00	\$1,217,146	11-14	\$2,096,000	
CONSTRUCT TYPE 4 STREAMBANKS	11,933	FT	\$64.00	\$763,699	11-14	\$1,315,000	
SUBTOTAL						\$62,620,000	
MONITORING	1	YR	\$150,000	\$150,000	2-50	\$1,930,000	
SUBTOTAL						\$1,930,000	
SUBTOTAL						\$64,550,000	
CONTINGENCY @ 20%			20%			\$12,910,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$9,683,000	
=====							
TOTAL COST:ALTERNATIVE 4A							\$87,140,000

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SILVER BOW CREEK - ALTERNATIVE 4A

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for five years (1996 - 2000). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream sources. Items for stream channel work are costed over four years (2005-2008).

- 1) The volume of excavated floodplain tailings will equal the total volume of floodplain tailings (2,832,000 CY), reduced by the volumes removed under remedy (174,800 CY from Reach 1; 194,200 CY from Reach 2; 132,900 CY from Reach 3; 144,200 CY from Reach 4). The final volume (2,185,900 CY) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 3,278,850 CY.
- 2a) 22.6 miles of stream channel will be excavated. The volume of material excavated will be 302,550 CY (201,700 CY x 1.5 expansion factor). Volume is the midpoint of the minimum and maximum volume estimates of contaminated bed sediments.
- 2b) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel. Costs include excavation and backfilling of the channel.
- 3) Hauling and disposal costs are based on an average distance of 10 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs for floodplain tailings are based on the volume excavated under restoration (3,278,850 CY), plus the volume excavated under remedy that would have been disposed of on-site (646,100 CY) and expanded by 50% (969,150 CY). The total volume of floodplain material that will be disposed of is 4,248,000 CY. Hauling and disposal costs for streambed sediments are based on the excavated volume of 302,550 CY.
- 4) Excavated floodplain areas are recontoured using cut and fill techniques, together with partial backfilling using imported material. The amount of backfill for recontouring the floodplain is 25% of the volume excavated under restoration (this assumes that floodplain areas excavated under remedy will be backfilled under remedy). The volume of backfill required is 819,712 CY (25% of 3,278,850 CY excavated by restoration).
- 5) The amount of growth media is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type. (Based on restoration of 748 acres to a baseline riparian wildlife habitat mix of 75% grass/forbs (561 acres) and 25% shrub/tree habitat types (187 acres), 86% of the total floodplain (1121 acres) will be revegetated to a grass/forb habitat type, and 14% (183 acres) will be revegetated to a shrub/forest habitat type). A 6-inch cover of growth media will therefore cover 1121 acres of excavated floodplain. The volume of growth media required is 904,273 CY (1121 acres x 43,560 square ft/acre x 0.5').
- 6) Revegetation costs are based on restoring 748 acres of floodplain to 25% shrub/forest habitat (187 acres) and 75% grass/forbs (agricultural) habitat (561 acres). Costs include seed, vegetation and labor. Revegetation of the remaining 556 acres will be accomplished under remedy.
- 7) The volume of material needed to backfill the excavated streambed is 50% of the amount of bed material excavated (302,550 CY), or 151,275 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of 22.6 miles of stream channel to 40% Type 2 banks (\$8/FT), 40% Type 3 banks (\$51/FT), and 20% Type 4 banks (\$64/FT). (Type 2 banks require the least amount of construction effort; Type 4 banks require the greatest amount of construction effort). The proportion of bank types is typical of a baseline condition.

- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$150,000 per year.

SILVER BOW CREEK REGION
ALTERNATIVE 4B

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE FLOODPLAIN TAILINGS	312,930 CY	\$6.00 CY	\$1,877,580	2-6	\$7,195,000	
2a) EXCAVATE STREAMBED	75,638 CY	\$6.00 CY	\$453,825	11-14	\$781,000	
2b) CONSTRUCT BYPASS CHANNEL	29,832 FT	\$22.50 FT	\$671,220	11-14	\$1,156,000	
3) HAULING AND DISPOSAL @ PONDS TAILINGS	312,930 CY	\$7.50 CY	\$2,346,975	2-6	\$8,994,000	
SEDIMENTS	75,638 CY	\$7.50 CY	\$567,281	11-14	\$977,000	
4) BACKFILL EXCAVATED FLOODPLAIN	78,233 CY	\$12.00 CY	\$938,790	2-6	\$3,597,000	
5) TOPSOIL/GROWTH MEDIA COVER	181,339 CY	\$10.00 CY	\$1,813,386	2-6	\$6,949,000	
6) REVEGETATE FLOODPLAIN						
SEED AND MULCH GRASSES/FORBS	108 AC	\$825 AC	\$88,976	2-6	\$341,000	
HAND PLANT SHRUBS/TREES	36 AC	\$4,620 AC	\$166,089	2-6	\$636,000	
7) RECONSTRUCT STREAM CHANNEL						
BACKFILL EXCAVATED STREAMBED	37,819 CY	\$12.00 CY	\$453,825	11-14	\$781,000	
CONSTRUCT CHANNEL BEDFORMS	29,832 LF	\$4.00 LF	\$119,328	11-14	\$205,000	
CONSTRUCT TYPE 2 STREAMBANKS	23,866 FT	\$8.00 FT	\$190,925	11-14	\$329,000	
CONSTRUCT TYPE 3 STREAMBANKS	23,866 FT	\$51.00 FT	\$1,217,146	11-14	\$2,096,000	
CONSTRUCT TYPE 4 STREAMBANKS	11,933 FT	\$64.00 FT	\$763,699	11-14	\$1,315,000	
SUBTOTAL					\$35,352,000	
MONITORING	1 YR	\$150,000 YR	\$150,000	2-50	\$1,930,000	
SUBTOTAL					\$1,930,000	
SUBTOTAL					\$37,282,000	
CONTINGENCY @ 20%		20%			\$7,456,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$5,592,000	
						=====
TOTAL COST:ALTERNATIVE 4B						\$50,330,000

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SILVER BOW CREEK - ALTERNATIVE 4B

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for five years (1996 - 2000). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream waste sources. Items for stream channel work are costed over four years (2005-2008).

- 1) The volume of excavated floodplain tailings will equal 1,043,100 CY (251,200 CY from Reach 1; 388,400 CY from Reach 2; 115,100 CY from Reach 3; 288,400 CY from Reach 4). This volume is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 1,564,650 CY.
- 2a) 22.6 miles of stream channel will be excavated. The volume of material excavated will be 302,550 CY (201,700 CY x 1.5 expansion factor). Volume is the midpoint of the minimum and maximum volume estimates of contaminated bed sediments.
- 2b) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel. Costs include excavation and backfilling of channel.
- 3) Hauling and disposal costs are based on an average hauling distance of 10 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs are calculated only for the volume of floodplain material (1,564,650 CY) and streambed sediments (302,550 CY) excavated under restoration (Items 1 and 2b). Materials excavated under remedy and disposed of on-site are assumed to have been sited at the edge of the floodplain and would not be excavated under restoration.
- 4) Excavated floodplain areas are recontoured using cut-and-fill techniques, together with partial backfilling using imported material. The amount of backfill for recontouring the floodplain is 25% of the volume excavated under restoration (this assumes that floodplain areas excavated under remedy will be backfilled under remedy). The volume of backfill required is 391,162 CY (25% of 1,564,650 CY excavated by restoration).
- 5) The amount of growth media is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type. (Based on restoration of 719 acres to a baseline riparian wildlife habitat mix of 75% grass/forbs (539 acres) and 25% shrub/tree habitat types (180 acres), 86% of the total floodplain (1124 acres) will be revegetated to a grass/forb habitat type, and 14% (180 acres) will be revegetated to a shrub/forest habitat type). A 6-inch cover of growth media will therefore cover 1124 acres of excavated floodplain. The volume of growth media required is 906,693 CY (1124 acres x 43,560 square ft/acre x 0.5').
- 6) Revegetation costs are based on restoring 719 acres of floodplain to 25% shrub/forest habitat (180 acres) and 75% grass/forbs (agricultural) habitat (539 acres). Costs include seed, vegetation and labor. Revegetation of the remaining 585 acres will be accomplished under remedy.
- 7) The amount of material needed to backfill the excavated streambed is 50% of the amount of bed material excavated (302,550 CY), or 151,275 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of 22.6 miles of stream channel to 40% Type 2 banks (\$8/FT), 40% Type 3 banks (\$51/FT), and 20% Type 4 banks (\$64/FT). (Type 2 banks require the least amount of construction effort; Type 4 banks require the greatest amount of construction effort). The proportion of bank types is typical of a baseline condition.

- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$150,000 per year.

SILVER BOW CREEK REGION
ALTERNATIVE 4C

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE FLOODPLAIN TAILINGS	461,500 CY	\$6.00 CY	\$2,769,000	2-4	\$6,791,000	
2a) EXCAVATE STREAMBED	77,025 CY	\$6.00 CY	\$462,150	11-12	\$425,000	
2b) CONSTRUCT BYPASS CHANNEL	28,512 FT	\$22.50 FT	\$641,520	11-12	\$590,000	
3) HAULING AND DISPOSAL @ PONDS TAILINGS	646,000 CY	\$7.50 CY	\$4,845,000	2-4	\$11,883,000	
SEDIMENTS	77,020 CY	\$7.50 CY	\$577,650	11-12	\$531,000	
4) BACKFILL EXCAVATED FLOODPLAIN	115,375 CY	\$12.00 CY	\$1,384,500	2-4	\$3,396,000	
5) TOPSOIL/GROWTH MEDIA COVER	92,498 CY	\$10.00 CY	\$924,977	2-4	\$2,269,000	
6) REVEGETATE FLOODPLAIN SEED AND MULCH GRASSES/FORBS	115 AC	\$825 AC	\$94,463	2-4	\$232,000	
HAND PLANT SHRUBS/TREES	38 AC	\$4,620 AC	\$176,330	2-4	\$432,000	
7) RECONSTRUCT STREAM CHANNEL BACKFILL EXCAVATED STREAMBED	38,513 CY	\$12.00 CY	\$462,150	11-12	\$425,000	
CONSTRUCT CHANNEL BEDFORMS	28,512 LF	\$4.00 LF	\$114,048	11-12	\$105,000	
CONSTRUCT TYPE 2 STREAMBANKS	22,810 FT	\$8.00 FT	\$182,477	11-12	\$168,000	
CONSTRUCT TYPE 3 STREAMBANKS	22,810 FT	\$51.00 FT	\$1,163,290	11-12	\$1,069,000	
CONSTRUCT TYPE 4 STREAMBANKS	11,405 FT	\$64.00 FT	\$729,907	11-12	\$671,000	
SUBTOTAL					\$28,987,000	
MONITORING	1 YR	\$150,000 YR	\$150,000	2-50	\$1,930,000	
SUBTOTAL					\$1,930,000	
SUBTOTAL					\$30,917,000	
CONTINGENCY @ 20%		20%			\$6,183,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$4,638,000	
TOTAL COST:ALTERNATIVE 4C						\$41,740,000

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SILVER BOW CREEK - ALTERNATIVE 4C

Floodplain excavation and restoration would begin the year following issuance of the Streamside Tailings Operable Unit Record of Decision (ROD), which is anticipated in 1995. Items for floodplain work are costed for three years (1996 - 1998). Stream channel excavation and reconstruction would begin the year after remediation and restoration actions have addressed upstream waste sources. Items for stream channel work are costed for two years (2005-2006).

- 1) The volume of excavated floodplain tailings will equal the total volume of floodplain tailings in Reaches 1 and 2 (1,292,000 CY), less the volume removed under remedy (369,000 CY). The final volume (923,000 CY) is expanded by 50 % to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 1,384,500 CY.
- 2a) 10.8 miles of stream channel will be excavated. The volume of material excavated will be 154,050 CY (102,700 x 1.5 expansion factor). Volume is the midpoint of the minimum and maximum volume estimates of contaminated bed sediments in Reaches 1 and 2.
- 2b) Dewatering for streambed excavation will be accomplished by construction of a temporary bypass channel.
- 3) Hauling and disposal costs are based on an average hauling distance of 10 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs are based on the total amount of floodplain material excavated under restoration (Item 1) (1,384,500 CY), plus the volume of floodplain materials excavated under remedy that would have been disposed of on-site, as expanded by 50 % (553,500 CY). The total volume of floodplain material that will be hauled and disposed of is 1,938,000 CY. Hauling and disposal costs for streambed sediments are based on the excavated volume (154,050 CY).
- 4) Excavated floodplain areas are recontoured using cut-and-fill techniques, together with partial backfilling using imported material. The amount of backfill for recontouring the floodplain is 25 % of the volume excavated under restoration (this assumes that floodplain areas excavated under remedy will be backfilled under remedy). The volume of backfill required is 346,125 CY (25 % of 1,384,500 CY excavated under restoration).
- 5) The amount of growth media is based on the percentage of floodplain that is being revegetated to a grass/forb (agricultural) habitat type. 458 acres will be restored to a habitat mix of 75 % grass/forbs (344 acres) and 25 % shrub/trees (114 acres). A 6-inch cover of growth media will cover 344 acres of excavated floodplain. The volume of growth media required is 277,493 CY (344 acres x 43,560 square ft/acre x 0.5').
- 6) Revegetation costs are based on restoring 436 acres of floodplain to 25 % shrub/forest habitat (114 acres) and 75 % grass/forbs (agricultural) habitat (344 acres). Costs include seed, vegetation and labor.
- 7) The amount of material needed to backfill the excavated streambed is 50 % of the amount of bed material excavated (154,050 CY), or 77,025 CY. Channel bedforms (runs, riffles, and pools) are constructed during backfilling of the streambed. Streambank reconstruction costs are based on reconstruction of 10.8 miles of stream channel to 40 % Type 2 banks (\$8/FT), 40 % Type 3 banks (\$51/FT), and 20 % Type 4 banks (\$64/FT). (Type 2 banks require the least amount of construction effort; Type 4 banks require the greatest amount of construction effort). The proportion of bank types is typical of a baseline condition.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$150,000 per year.

SILVER BOW CREEK REGION
ALTERNATIVE 4D

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1 YR		\$150,000 YR	\$150,000	2-50	\$1,930,000	
						=====	
TOTAL COST:ALTERNATIVE 40							\$1,930,000

SILVER BOW CREEK - ALTERNATIVE 4D

State oversight and monitoring assesses natural recovery of the resource. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs.

MONTANA POLE
ALTERNATIVE 5A

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) HIGHWAY & BERM REMOVAL AND REPLACE	1 LS	\$2,106,325 LS	\$2,106,000	3	\$1,719,000	
2) EXCAVATE CONTAMINATED SOIL	41,000 CY	\$6.00 CY	\$246,000	3	\$201,000	
3) HAUL CONTAMINATED SOIL	124,500 CY	\$5.00 CY	\$623,000	2-3	\$1,053,000	
4) DISPOSAL OFFSITE	124,500 CY	\$45.00 CY	\$5,603,000	2-3	\$9,468,000	
5) PLACE CLEAN SOIL						
a) HIGHWAY BERM	41,000 CY	\$12.00 CY	\$492,000	3	\$402,000	
b) SITE AREA	208,000 CY	\$12.00 CY	\$2,496,000	4	\$1,904,000	
6) WELL O & M	1 YR	\$30,700 YR	\$31,000	11-30	\$167,000	
7) PROCESS O & M (0.15 MGD)	1 YR	\$579,000 YR	\$579,000	11-30	\$3,118,000	
8) SLUDGE DISPOSAL	1 YR	\$56,700 YR	\$57,000	11-30	\$307,000	
SUBTOTAL					\$18,339,000	
MONITORING	1 YR	\$45,000 YR	\$45,000	2-30	\$516,000	
SUBTOTAL					\$516,000	
SUBTOTAL					\$18,855,000	
CONTINGENCY @ 20%		20%			\$3,771,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$2,828,000	
=====						
TOTAL COST:ALTERNATIVE 5A						\$25,450,000

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MONTANA POLE - ALTERNATIVE 5A

Work would begin in 1996, the year that actions implementing the Montana Pole Record of Decision are anticipated to begin.

- 1) Removal and reconstruction costs for the interstate highway and berms were estimated in 1993 by the Montana Department of Transportation. The cost assumes that approach fill material can be stockpiled at the Montana Pole site and reused. It was also assumed that the approaches would be reconstructed to their present width only, and not upgraded to federal highway standards.
- 2) Excavation of 41,000 cubic yards (CY) of contaminated soil under the highway berm would occur immediately after the berm is removed.
- 3) Hauling costs are based on hauling both the soil excavated under restoration (41,000 CY) and the 208,000 CY of soil which would have been treated and backfilled under remedy. Hauling would occur over two years (1996 - 1997), which is when excavation is projected to occur under remedy.
- 4) Soils would be disposed of in a RCRA subtitle C facility. Disposal would occur over two years (1996 - 1997).
- 5a) Clean fill (41,000 CY) would be backfilled in the area under the interstate highway during reconstruction of the highway in 1997.
- 5b) Clean fill (208,000 CY) would be backfilled in the area excavated under remedy in the year after excavation is complete (1998).
- 6) Well operation and maintenance (O & M) includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well. O & M of the 12 wells placed in remedy would occur in years 2005-2024. This is based on the assumption that the timeframe for pumping and treating projected for remedy under the ROD (30 years) would be considerably shortened by restoration actions. Costing assumes that pumping and treating under remedy would end in 10 years (1995-2004). Pumping and treating under restoration would occur from 2005 until 2024, at which time baseline would be achieved.
- 7) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment. O & M would occur between years 2005 - 2024 (Item 6).
- 8) Sludge disposal would occur in years 2005 - 2024 (Item 6). The method of disposal would be offsite incineration.
- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

MONTANA POLE
ALTERNATIVE 5B

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) HIGHWAY & BERM REMOVAL AND REPLACE	1 LS	\$2,106,325 LS	\$2,106,000	3	\$1,719,000	
2) EXCAVATE CONTAMINATED SOIL	41,000 CY	\$6.00 CY	\$246,000	3	\$201,000	
3) PLACE CLEAN SOIL	41,000 CY	\$12.00 CY	\$492,000	3	\$402,000	
4) LANDFARM CONTAMINATED SOIL	20,500 CY	\$30.00 CY	\$615,000	3-4	\$971,000	
5) WELL O & M	1 YR	\$30,700 YR	\$31,000	21-50	\$99,000	
6) PROCESS O & M (0.15 MGD)	1 YR	\$579,000 YR	\$579,000	21-50	\$1,857,000	
7) SLUDGE DISPOSAL	1 YR	\$56,700 YR	\$57,000	21-50	\$183,000	
SUBTOTAL					\$5,432,000	
MONITORING	1 YR	\$45,000 YR	\$45,000	3-50	\$540,000	
SUBTOTAL					\$540,000	
SUBTOTAL					\$5,972,000	
CONTINGENCY @ 20%		20%			\$1,194,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$896,000	
=====						
TOTAL COST:ALTERNATIVE 5B						\$8,060,000

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MONTANA POLE - ALTERNATIVE 5B

Work would begin in 1996, the year that actions implementing the Montana Pole Record of Decision are anticipated to begin.

- 1) Highway removal and reconstruction would proceed as described in Alternative 5A.
- 2) Excavation of 41,000 CY of contaminated soils under the highway will occur as described in Alternative 5A.
- 3) Clean fill (41,000 CY) would be backfilled in the excavated area under the interstate highway in 1997.
- 4) The 41,000 CY of contaminated soils will be biologically treated with the 208,000 CY of contaminated soils being similarly treated under remedy. Treating of soils removed from under the highway will occur over two years concurrent with and following removal (1997 - 1998).
- 5) Well operation and maintenance (O & M) includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well. O & M of the 12 wells placed in remedy would occur in years 2015 - 2044. This is based on the assumption that the timeframe for pumping and treating projected for remedy under the ROD (30 years) would be considerably shortened by restoration actions. Costing assumes that pumping and treating under remedy would end in 20 years (1995 - 2014). Costing for pumping and treating under restoration is based on a timeframe of 2015 to 2044.
- 6) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment. O & M for the 0.15 million gallon per day treatment plant constructed in remedy would occur between years 2015 - 2044 (Item 5).
- 7) Sludge disposal would occur in years 2015 - 2044 (Item 5). The method of disposal would be offsite incineration.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

MONTANA POLE
ALTERNATIVE 5C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) WELL O & M	1 YR		\$30,700 YR	\$31,000	31-50	\$43,000	
2) PROCESS O & M (0.15 MGD)	1 YR		\$579,000 YR	\$579,000	31-50	\$806,000	
3) SLUDGE DISPOSAL	1 YR		\$56,700 YR	\$57,000	31-50	\$79,000	
SUBTOTAL						\$928,000	
MONITORING	1 YR		\$45,000 YR	\$45,000	3-50	\$540,000	
SUBTOTAL						\$540,000	
SUBTOTAL						\$1,468,000	
CONTINGENCY @ 20%			20%			\$294,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$220,000	
=====							
TOTAL COST:ALTERNATIVE 5C							\$1,980,000

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MONTANA POLE - ALTERNATIVE 5C

Restoration actions would begin after groundwater pumping and treating under remedy end in the year 2024. Costing for pumping and treating under restoration is based on a timeframe of 2025 to 2044.

- 1) Operation and maintenance (O & M) of the 12 wells placed under remedy includes pump and valve replacement, and general maintenance such as redevelopment or cleaning of a well.
- 2) The treatment plant size (0.15 million gallons per day) is based on the volume of groundwater to be pumped under remedy. Process plant O & M includes electricity, personnel, and replacement of equipment.
- 3) Sludge would be disposed of by offsite incineration.
- 4) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

ANACONDA AREA RESOURCES - ALTERNATIVE 8B

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1999, to coordinate the disposal of other resource wastes at the ponds if necessary. The issuance of the Anaconda Regional Water and Waste Record of Decision (ROD) will be in 1996. The Anaconda Ponds would be capped over two years (1999 - 2000). The Opportunity Ponds would be capped over ten years (1999 - 2008).

ANACONDA PONDS

- 1) Capping entails grading, placement of a geogrid fabric where necessary, placement of a limestone layer, placement of a random fill layer, placement of growth media, and revegetation. Costing assumes that all steps would be accomplished over one-half of the 700 acres each year (350 acres per year).
 - a) Site grading will require moving 467,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.
 - b) The amount of geogrid fabric required for covering the ponds is 1,694,000 square yards (SY). Costs (\$2.00 per SY) include purchase and installation costs.
 - c) There is no cost associated with the limestone layer because this work will be coordinated under the anticipated remedy.
 - d) Lime treatment will cost \$1370 for application of 20 tons/acre.
 - e) A foot of slag will be used for a capillary break.
 - f) The volume of fill required for a one foot cover over 700 acres is 1,128,000 CY. The per unit cost (\$4 CY) is based on obtaining fill locally. The borrow area will supply the material for the fill layer, and the growth media. The borrow area, which will be approximately 60 acres, will be left as wetlands habitat and will therefore require minimal revegetation.
 - g) The volume of growth media required for a 12-inch cover over 700 acres is 1,128,000 CY. The borrow area will be utilized to obtain fill for the growth media. The growth media would be manufactured on-site prior to placement and would include a mixture of soil, agricultural by-products such as animal wastes, grain straw, wood chips and fertilizer.
 - h) The ponds will be revegetated with grasses and small shrubs following the placement of growth media. Revegetation cost is \$1,500/acre.
 - i) Operation and maintenance (O & M) includes maintaining the integrity of the cap, the runoff collection system and the vegetative cover. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the cap is completely constructed would not be captured.

OPPORTUNITY PONDS

- 2) The Opportunity Ponds cap will be constructed in the same manner as the Anaconda Ponds cap (Item 1). Costing assumes that all steps would be accomplished in one year over approximately one-tenth of the 3400 acres each year (340 acres per year). Capping will occur over ten years (1999 - 2008).
 - a) Site grading will require moving 4,800,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.
 - b) The amount of geogrid fabric required for covering the ponds is 8,225,000 square yards (SY). Costs

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1 YR	\$45,000 YR	\$45,000	3-50	\$540,000	
TOTAL COST : ALTERNATIVE 5D						\$540,000

MONTANA POLE - ALTERNATIVE 5D

State oversight and monitoring assesses natural recovery of the resource. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

ROCKER TIMBER PLANT
ALTERNATIVE 6A

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE SOIL	37,500 CY	\$6.00 CY	\$225,000	2	\$197,000	
2) HAUL TO IMPOUNDMENT	22,500 CY	\$5.00 CY	\$113,000	2	\$99,000	
3) DISPOSAL	22,500 CY	\$15.00 CY	\$338,000	2	\$295,000	
4) BACKFILL EXCAVATION	22,500 CY	\$12.00 CY	\$270,000	2	\$236,000	
5a) EXTRACTION WELLS	20 WELLS	\$15,900 WELLS	\$318,000	2	\$278,000	
5b) WELL O & M	1 YR	\$30,700 YR	\$30,700	3-50	\$368,000	
6a) TREATMENT PLANT CAPITAL	1 LS	\$576,000 PLANT	\$576,000	2	\$503,000	
6b) PROCESS O & M (0.072 MGD)	1 YR	\$277,920 YR	\$278,000	3-50	\$3,334,000	
7) SLUDGE DISPOSAL	1 YR	\$27,216 YR	\$27,000	3-50	\$324,000	
SUBTOTAL					\$5,634,000	
MONITORING	1 YR	\$45,000 YR	\$45,000	2-50	\$579,000	
SUBTOTAL					\$579,000	
SUBTOTAL					\$6,213,000	
CONTINGENCY @ 20%		20%			\$1,243,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$932,000	
=====						
TOTAL COST:ALTERNATIVE 6A						\$8,390,000

* YEAR ZERO IS 1994

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ROCKER TIMBER FRAMING AND TREATING PLANT - ALTERNATIVE 6A

All work at this site would occur in 1996, the year following the anticipated issuance of the Rocker Record of Decision (ROD). Operation and maintenance of the groundwater extraction and treatment system are costed through the year 2044, although the treatment plant would operate for a much longer period of time.

- 1) The volume of soil to be excavated is based on 15,000 cubic yards of soil with arsenic concentrations above 500 ppm plus a 50% expansion factor for a total volume of 22,500 cubic yards of contaminated material. Non-contaminated soil (15,000 CY) would be stockpiled for backfilling. The volume of soil to be excavated is 37,500 CY.
- 2) Hauling costs are based on a 10-mile hauling distance. The volume of material hauled is 22,500 CY (Item 1).
- 3) Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). The volume of material disposed of is 22,500 CY (Item 1).
- 4) The volume of clean soil is equal to the volume of excavated contaminated soil (22,500). Costs of replacing the 15,000 CY of contaminated soil excavated by remedy and revegetation would be assumed by remedy.
- 5a) The number of wells is based on one hundred foot well spacings in the most contaminated part of the arsenic plume.
- 5b) Well Operation and Maintenance (O & M) includes electrical pump and valve replacement, and general maintenance such as redevelopment or cleaning of wells.
- 6a) Treatment plant capacity would be 0.072 million gallons per day.
- 6b) Process O & M includes electricity, personnel, and periodic replacement of equipment.
- 7) Treatment plant sludge would be disposed of in accordance with applicable requirements.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

ROCKER TIMBER PLANT
ALTERNATIVE 6B

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE SOIL	37,500 CY	\$6.00 CY	\$225,000	2	\$197,000	
2) HAUL TO IMPOUNDMENT	22,500 CY	\$6.00 CY	\$135,000	2	\$118,000	
3) DISPOSAL	22,500 CY	\$15.00 CY	\$338,000	2	\$295,000	
4) BACKFILL EXCAVATION	22,500 CY	\$12.00 CY	\$270,000	2	\$236,000	
SUBTOTAL						\$846,000
MONITORING	1 YR	\$45,000 YR	\$45,000	2-50	\$579,000	
SUBTOTAL						\$579,000
SUBTOTAL						\$1,425,000
CONTINGENCY @ 20%		20%			\$285,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$214,000	
TOTAL COST:ALTERNATIVE 6B						\$1,920,000

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ROCKER TIMBER FRAMING AND TREATING PLANT - ALTERNATIVE 6B

All work at this site would occur in 1996, the year following the anticipated issuance of the Rocker Record of Decision (ROD).

- 1) The volume of soil to be excavated is based on 15,000 cubic yards of soil with arsenic concentrations above 500 ppm plus a 50% expansion factor for a total volume of 22,500 cubic yards of contaminated material. Non-contaminated soil (15,000 CY) would be stockpiled for backfilling. The volume of soil to be excavated is 37,500 CY.
- 2) Hauling costs are based on a 10-mile hauling distance. The volume of material hauled is 22,500 CY (Item 1).
- 3) Disposal costs are based on construction of a monofill in a location near Silver Bow Creek (although existing disposal sites could be used). The volume of material disposed of is 22,500 CY (Item 1).
- 4) The volume of clean soil is equal to the volume of excavated contaminated soil (22,500). Costs of replacing the 15,000 CY of contaminated soil excavated by remedy and revegetation would be assumed by remedy.
- 5) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

ROCKER TIMBER PLANT
ALTERNATIVE 6C

DESCRIPTION	QUANTITY		UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
	PER YR	UNIT					
WORK ITEM DESCRIPTION MONITORING	1	YR	\$45,000	YR	\$45,000	2-50	\$579,000
TOTAL COST:ALTERNATIVE 6C							\$579,000

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ROCKER TIMBER FRAMING AND TREATING PLANT - ALTERNATIVE 6C

State oversight and monitoring assesses recovery of the resource. This item will provide for monitoring of groundwater. Components of the monitoring program include well sample collection and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

SMELTER HILL AREA
ALTERNATIVE 7A

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) TREE/SHRUB AREA REVEGETATION	4,408 AC	367 AC	\$3,005 AC	\$1,104,000	3-14	\$7,659,000
2) GRASSLAND AREA REVEGETATION	2,702 AC	225 AC	\$2,025 AC	\$456,000	3-14	\$3,163,000
3) O & M FOR TREE/SHRUB AREAS	4,408 AC	367 AC	\$1,002 AC	\$368,000	4-15	\$2,386,000
4) O & M FOR GRASSLAND AREAS	2,702 AC	225 AC	\$675 AC	\$152,000	4-15	\$986,000
5) STEEP SLOPED >40% AREAS	2,242 AC	187 AC	\$2,080 AC	\$389,000	3-14	\$2,699,000
6) O & M FOR STEEP SLOPED AREAS	2,242 AC	187 AC	\$693 AC	\$130,000	4-15	\$843,000
7) SHRUBLAND AREAS	1,614 AC	135 AC	\$300 AC	\$40,000	3-14	\$277,000
SUBTOTAL						\$18,013,000
MONITORING						
	1 YR		\$45,000 YR	\$45,000	3-50	\$540,000
SUBTOTAL						\$540,000
SUBTOTAL						\$18,553,000
CONTINGENCY @ 20%			20%			\$3,711,000
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$2,783,000
						=====
TOTAL COST:ALTERNATIVE 7A						\$25,050,000

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UPLAND RESOURCES - ALTERNATIVE 7A

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision.

- 1) Tree/shrub area revegetation would occur over 4408 acres of the 10,966 acres of grossly injured area that would remain after remedy (11,366 ACRES-400 ACRES). The 4408 acres represent 62% of the 7110 acres of grossly injured area that is being targeted for revegetation to primarily tree/shrub environment. (7110 acres represents the injured areas that are not over 40% slope and are not shrublands). Planting would occur over twelve years (1997-2008).

TREE/SHRUB AREAS

COSTS/ACRE

a) SHRUB AND TREE COSTS.....	\$450
b) PLANTING COSTS.....	480
c) GRASS.....	200
d) TREE SHADE COSTS.....	150
e) GOUGING/BASINS.....	225
f) SITE PREP.....	550
g) FERTILIZER.....	75
h) SOIL PROTECTION.....	575
i) ORGANIC MATTER PLACEMENT.....	200
TOTAL.....	3005

- a) Tree and shrub costs are based on state and private nursery prices.
- b) Planting costs are based on an average of 150 trees planted per day. \$160 per day (\$20/hour) per person * three days/acre is \$480.
- c) Grass seed and application at \$200/acre are based on contractor estimates.
- d) Tree shade costs (\$150/acre) are based on 1994 wholesale prices from a St. Paul, Minnesota firm. Shades are \$1 apiece and will be needed for only one-third of the site plants.
- e) Gouging/Basins construction (\$225/acre) is based on contractor estimates.
- f) Site preparation (\$550/acre) is based on contractor estimates and includes costs for site leveling, and layout and excavation of needed drainage patterns.
- g) Fertilizer costs (\$75/acre) are based contractor estimates.
- h) Soil protection (\$570/acre) is based on contractor estimates for the following items:
Ripping, disking, liming, lime spreading, excelsior, sediment fence, rock gully plugs, rip-rap, water bars, snowfences and protection fences.
- i) Organic matter (\$200) will be introduced by planting annual grains such as barley and or millet. Organic matter composted on site will be applied to the the base of seedlings.

- 2) Grassland area revegetation would occur over 2702 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2702 acres represent 38% of the 7110 acres of grossly injured area that is being targeted for revegetation to primarily a grasslands environment. Planting would occur over a period of twelve years (1997-2008).

GRASSLAND AREAS

COSTS/ACRE

a) GRASS/SHRUBS/TREES/LABOR	\$400
b) SITE PREPARATION.....	550
c) GOUGE/BASIN PLACEMENT.....	225
d) FERTILIZER.....	75
e) SOIL PROTECTION.....	575
f) ORGANIC MATTER PLACEMENT.....	200
TOTAL.....	2025

a) Grass application is \$200/acre; shrubs or trees @100 plants/acre is \$100; labor is \$1/plant.

b-f) These items are discussed in 1) above.

- 3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, and equipment. O & M will occur during years 4 through 15 (1998-2009).
- 4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor and equipment. O & M will occur during years 4 through 15 (1998-2009).
- 5) Restoration of steep sloped areas will occur on 2242 acres of the grossly injured area. The 2242 acres represent the area with slopes over 40% slope. Soil protection costs are twice those of other areas due to the need for more protection effort on steeper slopes.

AREAS > 40% SLOPE

COSTS/ACRE

a) SHRUB AND TREE COSTS.....	\$450
b) LABOR.....	480
c) SOIL PROTECTION.....	1150
TOTAL.....	2080

a & b) Shrub and tree costs and labor are identified above.

c) Soil protection is double that in other areas due to greater need for stabilization in this area.

- 6) O & M costs are one-third of the cost of the initial efforts. Costs include materials, labor and equipment. O & M will occur during years 4-15 (1998-2009).
- 7) Shrubland area restoration will occur over 1614 acres of grossly injured area. The 1614 acres represents the area that was found to have deciduous shrub in the injury assessment work.

SHRUBLAND AREAS

COSTS/ACRE

a) SHRUB AND TREE COSTS.....	\$150
b) LABOR.....	150
TOTAL.....	300

a & b) Shrub and tree costs and labor are based on planting 150 plants per acre (\$1/plant and \$1/plant for labor).

- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a vegetation/wildlife habitat survey. All work is contracted, and include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

SMELTER HILL AREA
ALTERNATIVE 7B

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) TREE/SHRUB AREA REVEGETATION	3,306 AC	367 AC	\$3,005 AC	\$1,104,000	3-11	\$6,282,000
2) GRASSLAND AREA REVEGETATION	2,027 AC	225 AC	\$2,025 AC	\$456,000	3-11	\$2,595,000
3) O & M FOR TREE/SHRUB AREAS	3,306 AC	367 AC	\$1,002 AC	\$368,000	4-12	\$1,957,000
4) O & M FOR GRASSLAND AREAS	2,027 AC	225 AC	\$675 AC	\$152,000	4-12	\$808,000
5) STEEP SLOPED >40% AREAS	1,682 AC	187 AC	\$2,080 AC	\$389,000	3-11	\$2,214,000
6) O & M FOR STEEP SLOPED AREAS	1,682 AC	187 AC	\$693 AC	\$130,000	4-12	\$691,000
7) SHRUBLAND AREAS	1,211 AC	135 AC	\$300 AC	\$40,000	3-11	\$228,000
SUBTOTAL						\$14,775,000
MONITORING	1 YR		\$45,000 YR	\$45,000	3-50	\$540,000
SUBTOTAL						\$540,000
SUBTOTAL						\$15,315,000
CONTINGENCY @ 20%			20%			\$3,063,000
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$2,297,000
						=====
TOTAL COST:ALTERNATIVE 7B						\$20,680,000

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UPLAND RESOURCES - ALTERNATIVE 7B

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision. See the notes for Alternative 7A for costing details.

- 1) Tree/shrub area revegetation would occur over 3306 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 3306 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily tree/shrub environment (75 % of 4408 acres). The 4408 acres is the number of acres for tree/shrub restoration in alternative 7A. Planting would occur over a period of nine years (1997-2005).
- 2) Grassland area revegetation would occur over 2027 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2027 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily a grasslands environment (75 % of 2027 acres). Planting would occur over a period of nine years (1997-2005).
- 3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, and equipment. O & M will occur during years 4 through 12 (1998-2006).
- 4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor and equipment. O & M will occur during years 4 through 12 (1998-2006).
- 5) Steep sloped areas restoration will occur over 1682 acres of grossly injured area that would remain after remedy. The 1682 acres represents 75% of 1682 which the area with slopes over 40 % slope.
- 6) O & M costs are one-third of the cost of the initial efforts. Costs include materials, labor and equipment. O & M will occur during years 4 through 12 (1998-2006).
- 7) Shrubland area restoration will occur over 1211 acres of grossly injured area that would remain after remedy. The 1121 acres represents 75% of the area that was found to have deciduous shrub in the injury assessment work.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a vegetation/wildlife habitat survey. All work is contracted, and include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

SMELTER HILL AREA
ALTERNATIVE 7C

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) TREE/SHRUB AREA REVEGETATION	2,204 AC	367 AC	\$3,005 AC	\$1,104,000	3-8	\$4,596,000
2) GRASSLAND AREA REVEGETATION	1,351 AC	225 AC	\$2,025 AC	\$456,000	3-8	\$1,898,000
3) O & M FOR TREE/SHRUB AREAS	2,204 AC	367 AC	\$1,002 AC	\$368,000	4-9	\$1,432,000
4) O & M FOR GRASSLAND AREAS	1,351 AC	225 AC	\$675 AC	\$152,000	4-9	\$591,000
5) STEEP SLOPED >40% AREAS	1,121 AC	187 AC	\$2,080 AC	\$389,000	3-8	\$1,620,000
6) O & M FOR STEEP SLOPED AREAS	1,121 AC	187 AC	\$693 AC	\$130,000	4-9	\$506,000
7) SHRUBLAND AREAS	807 AC	135 AC	\$300 AC	\$40,000	3-8	\$167,000
SUBTOTAL						\$10,810,000
MONITORING						
	1 YR		\$45,000 YR	\$45,000	3-50	\$540,000
SUBTOTAL						\$540,000
SUBTOTAL						\$11,350,000
CONTINGENCY @ 20%			20%			\$2,270,000
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$1,703,000
=====						
TOTAL COST:ALTERNATIVE 7C						\$15,320,000

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UPLAND RESOURCES - ALTERNATIVE 7C

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision. See the note for Alternative 7A for costing details.

- 1) Tree/shrub area revegetation would occur over 2204 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 2204 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily tree/shrub environment (50% of 4408 acres). Planting would occur over a period of six years (1997-2002).
- 2) Grassland area revegetation would occur over 1351 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 1351 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily a grasslands environment (50% of 2702 acres). Planting would occur over a period of six years (1997-2002).
- 3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, and equipment. O & M will occur during years 4 through 9 (1998-2003).
- 4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor and equipment. O & M will occur during years 4 through 9 (1998-2003).
- 5) Steep sloped areas restoration will occur 1121 acres of grossly injured area that would remain after remedy. The 1121 acres represents 50% the area with slopes over 40% slope.
- 6) O & M costs are one-third of the cost of the initial efforts. Costs include materials, labor and equipment. O & M will occur during years 4 through 9 (1998-2003).
- 7) Shrubland area restoration will occur over 807 acres of grossly injured area that would remain after remedy. The 807 acres represents 50% of the area that was found to have deciduous shrub in the injury assessment work.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a vegetation/wildlife habitat survey. All work is contracted, and include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

SMELTER HILL AREA
ALTERNATIVE 7D

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) TREE/SHRUB AREA REVEGETATION	1,102 AC	367 AC	\$3,005 AC	\$1,104,000	3-5	\$2,531,000
2) GRASSLAND AREA REVEGETATION	676 AC	225 AC	\$2,025 AC	\$456,000	3-5	\$1,045,000
3) O & M FOR TREE/SHRUB AREAS	1,102 AC	367 AC	\$1,002 AC	\$368,000	4-6	\$788,000
4) O & M FOR GRASSLAND AREAS	676 AC	225 AC	\$675 AC	\$152,000	4-6	\$326,000
5) STEEP SLOPED >40% AREAS	561 AC	187 AC	\$2,080 AC	\$389,000	3-5	\$892,000
6) O & M FOR STEEP SLOPED AREAS	561 AC	187 AC	\$693 AC	\$130,000	4-6	\$278,000
7) SHRUBLAND AREAS	404 AC	135 AC	\$300 AC	\$40,000	3-5	\$92,000
SUBTOTAL						\$5,952,000
MONITORING						
	1 YR		\$45,000 YR	\$45,000	3-50	\$540,000
SUBTOTAL						\$540,000
SUBTOTAL						\$6,492,000
CONTINGENCY @ 20%			20%			\$1,298,000
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$974,000
=====						
TOTAL COST:ALTERNATIVE 7D						\$8,760,000

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UPLAND RESOURCES - ALTERNATIVE 7D

Restoration work on Smelter Hill, Stucky Ridge, and Mount Haggin would begin in 1997, the year after the issuance of the Regional Soils Record of Decision. See the notes for Alternative 7A for details.

- 1) Tree/shrub area revegetation would occur over 1102 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 1102 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily tree/shrub environment (25 % of 4408 acres). Planting would occur over a period of three years (1997-1999).
- 2) Grassland area revegetation would occur over 676 acres of the 10,966 acres of grossly injured area that would remain after remedy. The 676 acres represent the percentage of the grossly injured area that is being targeted for revegetation to primarily a grasslands environment (25 % of 2702 acres). Planting would occur over a period of three years (1997-1999).
- 3) Operation and maintenance (O & M) costs are one-third of the cost of the initial planting. Costs include materials, labor, and equipment. O & M will occur during years 4 through 6 (1998-2000).
- 4) O & M costs are one-third of the cost of the initial planting. Costs include materials, labor and equipment. O & M will occur during years 4 through 6 (1998-2000).
- 5) Steep sloped areas restoration will occur 560 acres of grossly injured area that would remain after remedy. The 560 acres represents 25% the area with slopes over 40% slope.
- 6) O & M costs are one-third of the cost of the initial efforts. Costs include materials, labor and equipment. O & M will occur during years 4 through 6 (1998-2000).
- 7) Shrubland area restoration will occur over 404 acres of grossly injured area that would remain after remedy. The 404 acres represents 25% of the area that was found to have deciduous shrub in the injury assessment work.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a vegetation/wildlife habitat survey. All work is contracted, and include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

SMELTER HILL AREA
ALTERNATIVE 7E

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1 YR	\$45,000 YR	\$45,000	3-50	\$540,000 =====	\$540,000
TOTAL COST:ALTERNATIVE 7E						

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UPLANDS RESOURCES - ALTERNATIVE 7E

State oversight and monitoring assesses recovery of the resource. This item will provide for monitoring of terrestrial resource. Components of the monitoring program include a vegetation/wildlife habitat survey. All work is contracted, and include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

ANACONDA AREA
ALTERNATIVE 8A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) CAP ANACONDA PONDS							
a) SITE GRADING	233,500	CY	\$6.00 CY	\$1,401,000	5-6	\$1,932,000	
b) GEOGRID FABRIC	847,000	SY	\$2.00 SY	\$1,694,000	5-6	\$2,337,000	
c) 3%-5% BENTONITE LAYER	1,695,000	SY	\$9.50 SY	\$16,102,500	5-6	\$22,211,000	
d) 3" LIMESTONE LAYER	112,900	CY	\$0.00 CY	\$0	5-6	\$0	
e) LIME TREATMENT	350	AC	\$1,370 AC	\$479,500	5-6	\$661,000	
f) CAPILLARY BREAK	564,500	CY	\$4.00 CY	\$2,258,000	5-6	\$3,115,000	
g) RANDOM FILL	564,500	CY	\$4.00 CY	\$2,258,000	5-6	\$3,115,000	
h) GROWTH MEDIA	564,500	CY	\$10.00 CY	\$5,645,000	5-6	\$7,786,000	
i) REVEGETATE POND SURFACE	350	AC	\$1,500 AC	\$525,000	5-6	\$724,000	
j) O & M FOR PONDS	1	YR	\$47,000 YR	\$47,000	7-50	\$425,000	
2) CAP OPPORTUNITY PONDS							
a) SITE GRADING	480,000	CY	\$6.00 CY	\$2,880,000	5-14	\$15,432,000	
b) GEOGRID FABRIC	822,500	SY	\$2.00 SY	\$1,645,000	5-14	\$8,814,000	
c) 3%-5% BENTONITE LAYER	1,645,000	SY	\$9.50 SY	\$15,627,500	5-14	\$83,736,000	
d) 3" LIMESTONE LAYER	137,100	CY	\$0.00 CY	\$0	5-14	\$0	
e) LIME TREATMENT	340	AC	\$1,370 AC	\$465,800	5-14	\$2,496,000	
f) CAPILLARY BREAK	548,533	CY	\$5.00 CY	\$2,742,667	5-14	\$14,696,000	
g) RANDOM FILL	548,533	CY	\$4.00 CY	\$2,194,133	5-14	\$11,757,000	
h) GROWTH MEDIA	548,533	CY	\$10.00 CY	\$5,485,333	5-14	\$29,392,000	
i) REVEGETATE POND SURFACE	340	AC	\$1,500 AC	\$510,000	5-14	\$2,733,000	
j) O & M FOR PONDS	1	YR	\$85,000 YR	\$85,000	15-50	\$430,000	
SUBTOTAL						\$211,792,000	
MONITORING	1	YR	\$90,000 YR	\$90,000	5-50	\$937,000	
SUBTOTAL						\$937,000	
SUBTOTAL						\$212,729,000	
CONTINGENCY @ 20%			20%			\$42,546,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$31,909,000	
TOTAL COST:ALTERNATIVE 8A							\$287,180,000

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ANACONDA AREA
ALTERNATIVE 8B

DESCRIPTION		QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) CAP ANACONDA PONDS							
a)	SITE GRADING	233,500 CY	\$6.00 CY	\$1,401,000	5-6	\$1,932,000	
b)	GEOGRID FABRIC	847,000 SY	\$2.00 SY	\$1,694,000	5-6	\$2,337,000	
c)	3" LIMESTONE LAYER	112,900 CY	\$0.00 CY	\$0	5-6	\$0	
d)	LIME TREATMENT	350 AC	\$1,370 AC	\$479,500	5-6	\$661,000	
e)	CAPILLARY BREAK	564,500 CY	\$5.00 CY	\$2,822,500	5-6	\$3,893,000	
f)	RANDOM FILL	564,500 CY	\$4.00 CY	\$2,258,000	5-6	\$3,115,000	
g)	GROWTH MEDIA	564,500 CY	\$10.00 CY	\$5,645,000	5-6	\$7,786,000	
h)	REVEGETATE POND SURFACE	350 AC	\$1,500 AC	\$525,000	5-6	\$724,000	
i)	O & M FOR PONDS	1 YR	\$47,000 YR	\$47,000	7-50	\$425,000	
2) CAP OPPORTUNITY PONDS							
a)	SITE GRADING	480,000 CY	\$6.00 CY	\$2,880,000	5-14	\$15,432,000	
b)	GEOGRID FABRIC	822,500 SY	\$2.00 SY	\$1,645,000	5-14	\$8,814,000	
c)	3" LIMESTONE LAYER	137,100 CY	\$0.00 CY	\$0	5-14	\$0	
d)	LIME TREATMENT	340 AC	\$1,370 AC	\$465,800	5-14	\$2,496,000	
e)	CAPILLARY BREAK	548,533 CY	\$5.00 CY	\$2,742,667	5-14	\$14,696,000	
f)	RANDOM FILL	548,533 CY	\$4.00 CY	\$2,194,133	5-14	\$11,757,000	
g)	GROWTH MEDIA	548,533 CY	\$10.00 CY	\$5,485,333	5-14	\$29,392,000	
h)	REVEGETATE POND SURFACE	340 AC	\$1,500 AC	\$510,000	5-14	\$2,733,000	
i)	O & M FOR PONDS	1 YR	\$85,000 YR	\$85,000	15-50	\$430,000	
SUBTOTAL						\$106,623,000	
MONITORING							
		1 YR	\$90,000 YR	\$90,000	5-50	\$937,000	
SUBTOTAL						\$937,000	
SUBTOTAL						\$107,560,000	
CONTINGENCY @ 20%			20%			\$21,512,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$16,134,000	
TOTAL COST:ALTERNATIVE 8B							\$145,210,000

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- a) Site grading will require moving 4,800,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.
 - b) The amount of geogrid fabric required for covering the ponds is 8,225,000 square yards (SY) (50% of the pond area). Costs (\$2.00 per SY) include purchase and installation costs.
 - c) The bentonite layer is comprised of fill material mixed with 3 to 5 percent bentonite. The layer will be six inches thick. Costs, at \$9.50 SY, are based on the area covered (16,450,000 SY).
 - d) There is no cost associated with the limestone layer because this work will be coordinated under the anticipated remedy.
 - e) Lime treatment will cost \$1370 for application of 20 tons/acre.
 - f) A foot of slag will be used for a capillary break.
 - g) The volume of fill required for a one foot cover over 3,400 acres is 5,485,333 CY. The per unit cost (\$4 CY) is based on obtaining fill locally. The borrow area will supply the unconsolidated fill and the growth media. The borrow area, which will be approximately 280 acres, will be left as wetlands habitat and will therefore only require minimal revegetation.
 - h) The volume of growth media required for a 12-inch cover over 3400 acres is 2,742,667 CY. The borrow area will be utilized to obtain fill for the growth media. The growth media would be manufactured on-site prior to placement and would include a mixture of soil, agricultural by-products such as animal wastes, grain straw, wood chips and fertilizer.
 - i) The ponds will be revegetated with grasses and small shrubs following the placement of growth media. Revegetation cost is \$1,500/acre.
 - j) Operation and maintenance (O & M) includes maintaining the integrity of the cap, the runoff collection system and the vegetative cover. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the cap is completely constructed are not captured.
- 3) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well installation, sample collection, and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

ANACONDA AREA
ALTERNATIVE 8B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) CAP ANACONDA PONDS							
a) SITE GRADING	233,500	CY	\$6.00	\$1,401,000	5-6	\$1,932,000	
b) GEOGRID FABRIC	847,000	SY	\$2.00	\$1,694,000	5-6	\$2,337,000	
c) 3" LIMESTONE LAYER	112,900	CY	\$0.00	\$0	5-6	\$0	
d) LIME TREATMENT	350	AC	\$1,370	\$479,500	5-6	\$661,000	
e) CAPILLARY BREAK	564,500	CY	\$5.00	\$2,822,500	5-6	\$3,893,000	
f) RANDOM FILL	564,500	CY	\$4.00	\$2,258,000	5-6	\$3,115,000	
g) GROWTH MEDIA	564,500	CY	\$10.00	\$5,645,000	5-6	\$7,786,000	
h) REVEGETATE POND SURFACE	350	AC	\$1,500	\$525,000	5-6	\$724,000	
i) D & M FOR PONDS	1	YR	\$47,000	\$47,000	7-50	\$425,000	
2) CAP OPPORTUNITY PONDS							
a) SITE GRADING	480,000	CY	\$6.00	\$2,880,000	5-14	\$15,432,000	
b) GEOGRID FABRIC	822,500	SY	\$2.00	\$1,645,000	5-14	\$8,814,000	
c) 3" LIMESTONE LAYER	137,100	CY	\$0.00	\$0	5-14	\$0	
d) LIME TREATMENT	340	AC	\$1,370	\$465,800	5-14	\$2,496,000	
e) CAPILLARY BREAK	548,533	CY	\$5.00	\$2,742,667	5-14	\$14,696,000	
f) RANDOM FILL	548,533	CY	\$4.00	\$2,194,133	5-14	\$11,757,000	
g) GROWTH MEDIA	548,533	CY	\$10.00	\$5,485,333	5-14	\$29,392,000	
h) REVEGETATE POND SURFACE	340	AC	\$1,500	\$510,000	5-14	\$2,733,000	
i) O & M FOR PONDS	1	YR	\$85,000	\$85,000	15-50	\$430,000	
SUBTOTAL						\$106,623,000	
MONITORING	1	YR	\$90,000	\$90,000	5-50	\$937,000	
SUBTOTAL						\$937,000	
SUBTOTAL						\$107,560,000	
CONTINGENCY @ 20%			20%			\$21,512,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$16,134,000	
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TOTAL COST:ALTERNATIVE 8B							\$145,210,000

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(\$2.00 per SY) include purchase and installation costs.

- c) There is no cost associated with the limestone layer because this work will be coordinated under the anticipated remedy.
 - d) Lime treatment will cost \$1370 for application of 20 tons/acre.
 - e) A foot of slag will be used for a capillary break.
 - f) The volume of fill required for a one foot cover over 3,400 acres is 5,485,333 CY. The per unit cost (\$4 CY) is based on obtaining fill locally. The borrow area will supply the material for the fill layer, and the growth media. The borrow area, which will be approximately 280 acres, will be left as wetlands habitat and will therefore not require revegetation.
 - g) The volume of growth media required for a 12-inch cover over 3400 acres is 2,742,667 CY. The borrow area will be utilized to obtain fill for the growth media. The growth media would be manufactured on-site prior to placement and would include a mixture of soil, agricultural by-products such as animal wastes, grain straw, wood chips and fertilizer.
 - h) The ponds will be revegetated with grasses and small shrubs following the placement of growth media. Revegetation cost is \$1,500/acre.
 - i) Operation and maintenance (O & M) includes maintaining the integrity of the cap, the runoff collection system and the vegetative cover. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the cap is completely constructed are not captured.
- 3) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well installation, sample collection, and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

ANACONDA AREA
ALTERNATIVE 8C

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) GRADE ANACONDA PONDS						
a) SITE GRADING	233,500 CY	\$6.00 CY	\$1,401,000	5-6	\$1,932,000	
b) HOLDING POND	27 AF	\$2,500 AF	\$67,500	5	\$348,000	
c) TREATMENT PLANT CAPITOL (0.18 MGD)	1 LS	\$720,000 LS	\$720,000	6	\$480,000	
d) PLANT O & M	1 YR	\$70,000 YR	\$70,000	7-50	\$632,000	
2) CAP OPPORTUNITY PONDS						
a) SITE GRADING	480,000 CY	\$6.00 CY	\$2,880,000	5-14	\$15,432,000	
b) GEOGRID FABRIC	822,500 SY	\$2.00 SY	\$1,645,000	5-14	\$8,814,000	
c) 3" LIMESTONE LAYER	137,100 CY	\$0.00 CY	\$0	5-14	\$0	
d) LIME TREATMENT	340 AC	1,370 AC	\$465,800	5-14	\$2,496,000	
e) CAPILLARY BREAK	548,533 CY	5 CY	\$2,742,667	5-14	\$14,696,000	
f) RANDOM FILL	548,533 CY	\$4.00 CY	\$2,194,133	5-14	\$11,757,000	
g) GROWTH MEDIA	548,533 CY	\$10.00 CY	\$5,485,333	5-14	\$29,392,000	
h) REVEGETATE POND SURFACE	340 AC	\$1,500 AC	\$510,000	5-14	\$2,733,000	
i) O & M FOR PONDS	1 YR	\$85,000 YR	\$85,000	15-50	\$430,000	
SUBTOTAL					\$89,142,000	
MONITORING	1 YR	\$90,000 YR	\$90,000	5-50	\$937,000	
SUBTOTAL					\$937,000	
SUBTOTAL					\$90,079,000	
CONTINGENCY @ 20%		20%			\$18,016,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$13,512,000	

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TOTAL COST:ALTERNATIVE 8C

\$121,610,000

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ANACONDA AREA RESOURCES - ALTERNATIVE 8C

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1999, to coordinate the disposal of other resource area wastes at the ponds if necessary. The issuance of the Anaconda Regional Water and Waste Record of Decision (ROD). The Anaconda Ponds would be graded over two years (1999 - 2000). The Opportunity Ponds would be capped over ten years (1999 - 2008).

ANACONDA PONDS

- 1) The Anaconda Ponds would be covered with limestone under remedy. The grading of the ponds and construction of a runoff collection system would be coordinated with the application of limestone.
- a) Site grading will require moving 467,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.
- b) The 34 acre-feet (six feet deep) holding pond will be constructed in 1997, the year site construction would begin. The pond would be lined with a compacted earth liner because the Anaconda Ponds would not be capped and runoff would be contaminated with hazardous substances.
- c) The treatment plant would have a capacity of 0.18 million gallons per day, based on the volume of water collected from a three and one-half inch storm or snowmelt event (204 acre-feet).
- d) Treatment plant O & M include water quality monitoring, electricity, general upkeep, periodic replacement of equipment, sludge disposal and personnel costs. The treatment plant would be constructed in 1998, the year following initial site grading.

OPPORTUNITY PONDS

- 2) Capping of the Opportunity Ponds would occur over ten years (1999 - 2008), as described in Alternative 8B.
- 3) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well installation, sample collection, and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

ANACONDA AREA
ALTERNATIVE 8D

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) GRADE ANACONDA PONDS						
a) SITE GRADING	233,500 CY	\$6.00 CY	\$1,401,000	5-6	\$1,932,000	
b) HOLDING POND	27 AF	\$2,500 AF	\$67,500	5	\$355,000	
c) RUNOFF COLLECTION SYSTEM	3 MI	\$264,000 MI	\$792,000	5	\$565,000	
d) RUNOFF COLLECTION SYSTEM O & M	1 YR	\$15,000 YR	\$15,000	7-50	\$136,000	
e) TREATMENT PLANT CAPITAL (0.18 MGD)	1 LS	\$720,000 LS	\$720,000	6	\$480,000	
f) PLANT O & M	1 YR	\$70,000 YR	\$70,000	7-50	\$632,000	
2) GRADE OPPORTUNITY PONDS						
a) SITE GRADING	800,000 CY	\$6.00 CY	\$4,800,000	5-10	\$17,455,000	
b) HOLDING POND	182 AF	\$2,500 AF	\$455,000	5	\$324,000	
c) RUNOFF COLLECTION SYSTEM	11 MI	\$264,000 MI	\$2,904,000	5	\$2,071,000	
d) RUNOFF COLLECTION SYSTEM O & M	1 YR	\$55,000 YR	\$55,000	11-50	\$373,000	
e) TREATMENT PLANT CAPITAL (1 MGD)	1 LS	\$4,000,000 LS	\$4,000,000	6	\$2,665,000	
f) PLANT O & M	1 YR	\$484,000 YR	\$484,000	7-50	\$4,373,000	
SUBTOTAL					\$31,361,000	
MONITORING	1 YR	\$90,000 YR	\$90,000	5-50	\$937,000	
SUBTOTAL					\$937,000	
SUBTOTAL					\$32,298,000	
CONTINGENCY @ 20%		20%			\$6,460,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$4,845,000	

TOTAL COST:ALTERNATIVE 8D

\$43,600,000

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ANACONDA AREA RESOURCES - ALTERNATIVE 8D

Restoration work at the Anaconda Ponds and Opportunity Ponds would begin in 1999, to coordinate the disposal of wastes from other resource areas at the ponds if necessary. The issuance of the Anaconda Regional Water and Waste Record of Decision (ROD) will be in 1996. The Anaconda Ponds would be graded over two years (1999 - 2000). The Opportunity Ponds would be graded over six years (1999 - 2004).

ANACONDA PONDS

- 1) The Anaconda Ponds would be graded and covered as described in Alternative 8C with the addition of a runoff collection system (see items c & d below).

OPPORTUNITY PONDS

- 2) Grading and covering of the Opportunity ponds would occur in years 1999-2004. The Opportunity Ponds would be covered with limestone under remedy. The grading of the ponds and construction of a runoff collection system would be coordinated with the application of limestone.
 - a) Site grading will require moving 4,800,000 cubic yards (CY) of material. Grading creates a two percent slope with alternating ridges and swales that enhances surface runoff to a perimeter collection system.
 - b) The 182 acre-feet (six feet deep) holding pond will be constructed in 1999, the year site construction would begin. The pond would be lined with a compacted earth liner because the Opportunity Ponds would not be capped and runoff would be contaminated with hazardous substances. The pond is sized to collect runoff from a three and one-half inch storm or snowmelt event. Construction would occur in 1997 (the first year of site construction).
 - c) The runoff collection system consists of an unlined ditch excavated around the perimeter of the ponds, and sloped to flow to one or more holding ponds.
 - d) Operation and maintenance (O & M) of the runoff collection system includes maintaining the integrity of the runoff collection system. O & M costs begin the year following completion of site grading and capping. Therefore, O & M costs during the time before the site is completely graded would not be captured.
 - e) The treatment plant would have a capacity of 1 million gallons per day, based on the volume of water collected from a three and one-half inch storm or snowmelt event (1,090 acre-feet).
 - f) Treatment plant O & M include water quality monitoring, electricity, general upkeep, periodic replacement of equipment, sludge disposal and personnel costs. The treatment plant would be constructed in 2000, the year after site grading begins.
- 3) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item will provide for monitoring of groundwater. Components of the monitoring program include well installation, sample collection, and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

ANACONDA AREA
ALTERNATIVE 8E

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1	YR	\$90,000	YR	\$90,000	5-50	\$937,000
TOTAL COST:ALTERNATIVE 8E							\$937,000

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ANACONDA AREA RESOURCES - ALTERNATIVE 8E

State oversight and monitoring assesses natural recovery of the resource. This item will provide for monitoring of groundwater. Components of the monitoring program include well installation, sample collection, and laboratory costs incurred by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$90,000 per year.

CLARK FORK RIVER
ALTERNATIVE 9A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	650,230	CY	\$6.00	\$3,901,000	4-9	\$15,178,000	
2) REMOVE RIVERBANKS	26,136	CY	\$6.00	\$157,000	4-8	\$525,000	
3) HAULING AND DISPOSAL @ PONDS FLOODPLAIN TAILINGS	650,230	CY	\$9.50	\$6,177,000	4-9	\$24,034,000	
RIVERBANK MATERIALS	49,896	CY	\$9.50	\$474,000	4-8	\$1,586,000	
4) BACKFILL EXCAVATED FLOODPLAIN	162,558	CY	\$12.00	\$1,951,000	4-9	\$7,591,000	
5) REVEGETATE FLOODPLAIN SEED AND MULCH GRASSES/FORBS	734	AC	\$825	\$605,000	4-9	\$2,354,000	
HAND PLANT SHRUBS/TREES	6	AC	\$4,620	\$30,000	4-9	\$117,000	
6) RECONSTRUCT RIVERBANKS CONSTRUCT TYPE 1 STREAMBANKS (50%)	12,830	FT	\$0.00	\$0	4-8	\$0	
CONSTRUCT TYPE 2 STREAMBANKS (20%)	5,132	FT	\$8.00	\$41,000	4-8	\$137,000	
CONSTRUCT TYPE 3 STREAMBANKS (20%)	5,132	FT	\$51.00	\$262,000	4-8	\$877,000	
CONSTRUCT TYPE 4 STREAMBANKS (10%)	2,566	FT	\$84.00	\$216,000	4-8	\$723,000	
7) STABILIZE RIVERBANKS	25,661	FT	\$5.00	\$128,000	4-8	\$428,000	
8) FLOW AUGMENTATION	6,150	AF	\$42.00	\$258,000	10-50	\$1,880,000	
SUBTOTAL						\$55,430,000	
MONITORING	1	YR	\$500,000	\$500,000	4-50	\$5,588,000	
SUBTOTAL						\$5,588,000	
SUBTOTAL						\$61,018,000	
CONTINGENCY @ 20%			20%			\$12,204,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$9,153,000	

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TOTAL COST:ALTERNATIVE 9A \$82,380,000

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CLARK FORK RIVER - ALTERNATIVE 9A

Restoration work will occur over six years beginning the year following issuance of the Clark Fork River Operable Unit Record of Decision (ROD). The ROD is anticipated in the year 1997.

- 1) The volume of excavated material is based on the estimated volume of tailings and associated contaminated floodplain material (2,791,000 CY), less the volume excavated during streambank reconstruction (Item 2 - 190,080 CY). This volume (2,600,920) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 3,901,380 CY.
- 2) Riverbanks between Warm Springs and Deer Lodge that are located in tailings-impacted floodplain areas would be removed and reconstructed, or stabilized. Approximately 90% of the banks in this reach are in such areas. One-half of these riverbanks would be removed and reconstructed, and one-half would be stabilized by revegetating with shrubs. Based on a reach length of 27 miles, an excavation width of 10 feet, and a bank height of 4 feet, 190,080 CY of material would be excavated (one-half of 27 miles x 2 banks x .9 x 5280'/mile x 10' width x 4' bank height). Under remedy, 59,400 CY of material would be pulled away from the river and redeposited on the floodplain further away from the river (27 miles x 5280'/mile x 45% excavation rate x 2 banks x 10' excavation width x 1.25' tailings thickness). For costing bank excavation, the total volume of bank material (190,080 CY) is reduced by 59,400 CY.
- 3) Hauling and disposal costs are based on an average distance of 30 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs for floodplain tailings are based on the volume excavated under restoration (3,901,380 CY). Hauling and disposal costs for riverbank materials are based on the volume excavated under restoration (130,680 CY), plus the volume that would have been excavated under remedy (59,400 CY) and disposed of on the floodplain.
- 4) Excavated floodplain areas are partially backfilled using imported material. The amount of backfill for recontouring the floodplain is 25% of the excavated volume. The volume of backfill required is 975,345 CY (25% of 3,901,380 CY).
- 5) Revegetation costs are based on restoring 215 acres of riparian resources to 25% shrub/forest habitat (54 acres) and 75% grass/forbs (agricultural) habitat (161 acres), less the 59 acres of floodplain revegetated in conjunction with riverbank reconstruction (Item 5). Revegetation on these 59 acres will contribute to restoration of riparian resources. Of these 59 acres, 15 acres will be shrub/forest habitat type and 44 acres will be grass/forb habitat type. Costs for floodplain revegetation will therefore be based on 39 acres of shrub/forest habitat and 117 acres of grass/forb habitat. The remaining 4285 acres would be revegetated to control erosion. For costing purposes, it was assumed that these 4285 acres have a grass/forb vegetative cover type. Costs include seed, vegetation stock and labor.
- 6) Costs are based on reconstruction of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. (13.5 miles x 2 banks x .9 x 5280'/mile.) Riverbanks will be reconstructed to 50% Type 1 banks (\$0/FT), 20% Type 2 banks (\$8/FT), 20% Type 3 banks (\$51/FT), and 10% Type 4 banks (\$84/FT). Type 1 banks require the least amount of reconstruction effort; Type 4 banks require the greatest amount of reconstruction effort. Riverbank reconstruction will revegetate approximately 59 acres of floodplain (27 miles x 2 banks x 90% x 5280'/mile x 10' width /43,560 square feet per acre).
- 7) Costs are based on stabilization of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. Riverbanks will be stabilized by hand planting willow and other shrub stock at a density of 5 per lineal foot. Costs for stock and labor are \$5 per lineal foot.
- 8) The amount of water necessary to augment flows in the Clark Fork River by 100 cubic feet per second for nine months of the year is 6,150 acre-feet. This water would be acquired at the market price of \$42.00 per acre/foot. The cost is incurred annually beginning the year after completion of riverbank reconstruction (2004). The cost is held constant over time, although water prices could rise substantially.

- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on six-months of time at \$40,000 per year, is \$20,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$500,000 per year.

CLARK FORK RIVER
ALTERNATIVE 9B

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) EXCAVATE FLOODPLAIN TAILINGS	755,960	CY	\$6.00 CY	\$4,536,000	4-6	\$9,717,000	
2) REMOVE RIVERBANKS	26,136	CY	\$6.00 CY	\$157,000	4-8	\$525,000	
3) HAULING AND DISPOSAL @ PONDS FLOODPLAIN TAILINGS	755,960	CY	\$7.00 CY	\$5,292,000	4-6	\$11,337,000	
RIVERBANK MATERIALS	49,896	CY	\$7.00 CY	\$349,000	4-8	\$1,168,000	
4) BACKFILL EXCAVATED FLOODPLAIN	188,990	CY	\$12.00 CY	\$2,268,000	4-6	\$4,859,000	
5) REVEGETATE FLOODPLAIN SEED AND MULCH GRASSES/FORBS	725	AC	\$825 AC	\$598,000	4-6	\$1,281,000	
HAND PLANT SHRUBS/TREES	16	AC	\$4,620 AC	\$72,000	4-6	\$154,000	
6) RECONSTRUCT RIVERBANKS CONSTRUCT TYPE 1 STREAMBANKS (50%)	12,830	FT	\$0.00 FT	\$0	4-8	\$0	
CONSTRUCT TYPE 2 STREAMBANKS (20%)	5,132	FT	\$8.00 FT	\$41,000	4-8	\$137,000	
CONSTRUCT TYPE 3 STREAMBANKS (20%)	5,132	FT	\$51.00 FT	\$262,000	4-8	\$877,000	
CONSTRUCT TYPE 4 STREAMBANKS (10%)	2,566	FT	\$84.00 FT	\$216,000	4-8	\$723,000	
7) STABILIZE RIVERBANKS	25,661	FT	\$5.00 FT	\$128,000	4-8	\$428,000	
8) FLOW AUGMENTATION	6,150	AF	\$42.00 AF	\$258,000	9-50	\$2,020,000	
SUBTOTAL						\$33,226,000	
MONITORING	1	YR	\$500,000 YR	\$500,000	4-50	\$5,588,000	
SUBTOTAL						\$5,588,000	
SUBTOTAL						\$38,814,000	
CONTINGENCY @ 20%			20%			\$7,763,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$5,822,000	
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TOTAL COST:ALTERNATIVE 9B							\$52,400,000

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CLARK FORK RIVER - ALTERNATIVE 9B

Restoration work will occur over three years beginning the year following the issuance of the Clark Fork River Operable Unit Record of Decision (ROD). The ROD is anticipated in the year 1997.

- 1) The volume of excavated material is based on the estimated volume of tailings and associated contaminated floodplain material (1,702,000 CY), less the volume excavated during streambank reconstruction (Item 2 - 190,080 CY). This volume (1,511,920) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 2,267,880 CY.
- 2) Riverbanks between Warm Springs and Deer Lodge that are located in tailings-impacted floodplain areas would be removed and reconstructed, or stabilized. Approximately 90% of the banks in this reach are in such areas. One-half of these riverbanks would be removed and reconstructed, and one-half would be stabilized by revegetating with shrubs. Based on a reach length of 27 miles, an excavation width of 10 feet, and a bank height of 4 feet, 190,080 CY of material would be excavated (one-half of 27 miles x 2 banks x .9 x 5280'/mile x 10' width x 4' bank height). Under remedy, 59,400 CY of material would be pulled away from the river and redeposited on the floodplain further away from the river (27 miles x 5280'/mile x 45% excavation rate x 2 banks x 10' excavation width x 1.25' tailings thickness). For costing bank excavation, the total volume of bank material (190,080 CY) is reduced by 59,400 CY.
- 3) Hauling and disposal costs are based on an average distance of 20 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs for floodplain tailings are based on the volume excavated under restoration (2,267,880 CY). Hauling and disposal costs for riverbank materials are based on the volume excavated under restoration (130,680 CY), plus the volume that would have been excavated under remedy (59,400 CY) and disposed of on the floodplain.
- 4) Excavated floodplain areas are partially backfilled using imported material. The amount of backfill for recontouring the floodplain is 25% of the excavated volume. The volume of backfill required is 566,970 CY (25% of 2,267,880 CY).
- 5) Revegetation costs are based on restoring 215 acres of riparian resources to 25% shrub/forest habitat (54 acres) and 75% grass/forbs (agricultural) habitat (161 acres), less the 29 acres of floodplain revegetated in conjunction with riverbank reconstruction (Item 5). Revegetation on these 29 acres will contribute to restoration of riparian resources. Of these 29 acres, 7 acres will be shrub/forest habitat type and 22 acres will be grass/forb habitat type. Costs for floodplain revegetation will therefore be based on 47 acres of shrub/forest habitat and 139 acres of grass/forb habitat. The remaining 2035 acres would be revegetated to control erosion. For costing purposes, it was assumed that these 2035 acres have a grass/forb vegetative cover type. Costs include seed, vegetation stock and labor.
- 6) Costs are based on reconstruction of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. (13.5 miles x 2 banks x .9 x 5280'/mile.) Riverbanks will be reconstructed to 50% Type 1 banks (\$0/FT), 20% Type 2 banks (\$8/FT), 20% Type 3 banks (\$51/FT), and 10% Type 4 banks (\$84/FT). Type 1 banks require the least amount of reconstruction effort; Type 4 banks require the greatest amount of reconstruction effort. Riverbank reconstruction will revegetate approximately 59 acres of floodplain (27 miles x 2 banks x 90% x 5280'/mile x 10' width /43,560 square feet per acre).
- 7) Costs are based on stabilization of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. Riverbanks will be stabilized by hand planting willow and other shrub stock at a density of 5 per lineal foot. Costs for stock and labor are \$5 per lineal foot.
- 8) The amount of water necessary to augment flows in the Clark Fork River by 100 cubic feet per second for nine months of the year is 6,150 acre-feet. This water would be acquired at the market price of \$42.00 per acre/foot. The cost is incurred annually beginning the year after completion of riverbank reconstruction (2004). The cost is held constant over time, although water prices could rise substantially.

- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on six-months of time at \$40,000 per year, is \$20,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$500,000 per year.

CLARK FORK RIVER
ALTERNATIVE 9C

DESCRIPTION	QUANTITY PER YR UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION						
1) EXCAVATE FLOODPLAIN TAILINGS	725,940 CY	\$6.00 CY	\$4,356,000	4-5	\$6,429,000	
2) REMOVE RIVERBANKS	26,136 CY	\$6.00 CY	\$157,000	4-8	\$525,000	
3) HAULING AND DISPOSAL @ PONDS FLOODPLAIN TAILINGS	725,940 CY	\$5.50 CY	\$3,993,000	4-5	\$5,893,000	
RIVERBANK MATERIALS	49,896 CY	\$5.50 CY	\$274,000	4-8	\$917,000	
4) BACKFILL EXCAVATED FLOODPLAIN	181,485 CY	\$12.00 CY	\$2,178,000	4-5	\$3,214,000	
5) REVEGETATE FLOODPLAIN						
SEED AND MULCH GRASSES/FORBS	536 AC	\$825 AC	\$442,000	4-5	\$652,000	
HAND PLANT SHRUBS/TREES	27 AC	\$4,620 AC	\$124,000	4-5	\$183,000	
6) RECONSTRUCT RIVERBANKS						
CONSTRUCT TYPE 1 STREAMBANKS (50%)	12,830 FT	\$0.00 FT	\$0	4-8	\$0	
CONSTRUCT TYPE 2 STREAMBANKS (20%)	5,132 FT	\$8.00 FT	\$41,000	4-8	\$137,000	
CONSTRUCT TYPE 3 STREAMBANKS (20%)	5,132 FT	\$51.00 FT	\$262,000	4-8	\$877,000	
CONSTRUCT TYPE 4 STREAMBANKS (10%)	2,566 FT	\$84.00 FT	\$216,000	4-8	\$723,000	
7) STABILIZE RIVERBANKS	25,661 FT	\$5.00 FT	\$128,000	4-8	\$428,000	
8) FLOW AUGMENTATION	6,150 AF	\$42.00 AF	\$258,000	9-50	\$2,020,000	
SUBTOTAL					\$21,998,000	
MONITORING	1 YR	\$500,000 YR	\$500,000	4-50	\$5,588,000	
SUBTOTAL					\$5,588,000	
SUBTOTAL					\$27,586,000	
CONTINGENCY @ 20%		20%			\$5,517,000	
ENGINEERING AND ADMINISTRATION @ 15%		15%			\$4,138,000	
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TOTAL COST:ALTERNATIVE 9C						\$37,240,000

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CLARK FORK RIVER - ALTERNATIVE 9C

Restoration work will occur over three years beginning the year following the issuance of the Clark Fork River Operable Unit Record of Decision (ROD). The ROD is anticipated in the year 1997.

- 1) The volume of excavated material is based on the estimated volume of tailings and associated contaminated floodplain material (1,158,000 CY), less the volume excavated during streambank reconstruction (Item 2 - 190,080 CY). This volume (967,920) is expanded by 50% to account for the additional material unavoidably removed during waste excavation (this is based on experience with removal actions elsewhere in the Clark Fork Basin). The final volume of excavated material is 1,451,880 CY.
- 2) Riverbanks between Warm Springs and Deer Lodge that are located in tailings-impacted floodplain areas would be removed and reconstructed, or stabilized. Approximately 90% of the banks in this reach are in such areas. One-half of these riverbanks would be removed and reconstructed, and one-half would be stabilized by revegetating with shrubs. Based on a reach length of 27 miles, an excavation width of 10 feet, and a bank height of 4 feet, 190,080 CY of material would be excavated (one-half of 27 miles x 2 banks x .9 x 5280'/mile x 10' width x 4' bank height). Under remedy, 59,400 CY of material would be pulled away from the river and redeposited on the floodplain further away from the river (27 miles x 5280'/mile x 45% excavation rate x 2 banks x 10' excavation width x 1.25' tailings thickness). For costing bank excavation, the total volume of bank material (190,080 CY) is reduced by 59,400 CY.
- 3) Hauling and disposal costs are based on an average distance of 20 miles to the Anaconda and/or Opportunity Ponds. Hauling and disposal costs for floodplain tailings are based on the volume excavated under restoration (2,267,880 CY). Hauling and disposal costs for riverbank materials are based on the volume excavated under restoration (130,680 CY), plus the volume that would have been excavated under remedy (59,400 CY) and disposed of on the floodplain.
- 4) Excavated floodplain areas are partially backfilled using imported material. The amount of backfill for recontouring the floodplain is 25% of the excavated volume. The volume of backfill required is 362,970 CY (25% of 1,451,880 CY).
- 5) Revegetation costs are based on restoring 215 acres of riparian resources to 25% shrub/forest habitat (54 acres) and 75% grass/forbs (agricultural) habitat (161 acres), less the 29 acres of floodplain revegetated in conjunction with riverbank reconstruction (Item 5). It is assumed that riverbank stabilization does not contribute substantially to restoration of riparian vegetation. The remaining 910 acres would be revegetated to control erosion. For costing purposes, it was assumed that these 910 acres have a grass/forb vegetative cover type. Costs include seed, vegetation stock and labor.
- 6) Costs are based on reconstruction of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. (13.5 miles x 2 banks x .9 x 5280'/mile.) Riverbanks will be reconstructed to 50% Type 1 banks (\$0/FT), 20% Type 2 banks (\$8/FT), 20% Type 3 banks (\$51/FT), and 10% Type 4 banks (\$84/FT). Type 1 banks require the least amount of reconstruction effort; Type 4 banks require the greatest amount of reconstruction effort. Riverbank reconstruction will revegetate approximately 59 acres of floodplain (27 miles x 2 banks x 90% x 5280'/mile x 10' width /43,560 square feet per acre).
- 7) Costs are based on stabilization of 128,304 feet of riverbanks between Warm Springs and Deer Lodge. Riverbanks will be stabilized by hand planting willow and other shrub stock at a density of 5 per lineal foot. Costs for stock and labor are \$5 per lineal foot.
- 8) The amount of water necessary to augment flows in the Clark Fork River by 100 cubic feet per second for nine months of the year is 6,150 acre-feet. This water would be acquired at the market price of \$42.00 per acre/foot. The cost is incurred annually beginning the year after completion of riverbank reconstruction (2004). The cost is held constant over time, although water prices could rise substantially.

- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on six-months of time at \$40,000 per year, is \$20,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$500,000 per year.

CLARK FORK RIVER
ALTERNATIVE 90

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION MONITORING	1	YR	\$500,000	YR	\$500,000	4-50	\$5,588,000
TOTAL COST:ALTERNATIVE 90							\$5,588,000

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CLARK FORK RIVER - ALTERNATIVE 9D

State oversight and monitoring assesses natural recovery of the resource. Components of the monitoring program include a water quality, benthic macroinvertebrate and bed sediment sampling; a fish population survey; a vegetation/wildlife habitat survey; and a streambank evaluation survey. Components of the monitoring program include data collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on six-months of time at \$40,000 per year, is \$20,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$500,000 per year.

MILLTOWN RESERVOIR
ALTERNATIVE 10A

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) LEVEE CONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	10	\$2,033,000	
2) LEVEE RECONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	13	\$1,660,000	
3) EXCAVATING AND DEWATERING	1,100,000	CY	\$6.00 CY	\$6,600,000	11-16	\$15,992,000	
4) HAULING	1,100,000	CY	\$5.00 CY	\$5,500,000	11-16	\$13,327,000	
5) DISPOSAL	1,100,000	CY	\$15.00 CY	\$16,500,000	11-16	\$39,981,000	
6) WATER TREATMENT DURING EXCAVATION							
TREATMENT FACILITY (1.4 MGD)	1	LS	\$5,600,000 LS	\$5,600,000	10	\$2,847,000	
PLANT O & M	1	YR	\$677,600 YR	\$678,000	11-16	\$1,643,000	
7) DAM REMOVAL	1	LS	\$10,000,000 LS	\$10,000,000	17	\$3,166,000	
SUBTOTAL						\$80,649,000	
MONITORING	1	YR	\$45,000 YR	\$45,000	10-50	\$328,000	
SUBTOTAL						\$328,000	
SUBTOTAL						\$80,977,000	
CONTINGENCY @ 20%			20%			\$16,195,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$12,147,000	
							=====
TOTAL COST:ALTERNATIVE 10A							\$109,320,000

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MILLTOWN RESERVOIR - ALTERNATIVE 10A

Although issuance of the Milltown Reservoir Operable Unit Record of Decision (ROD) is anticipated in 1996, excavation of reservoir sediments would not begin until remedy and restoration actions on the Clark Fork River had been completed. This is estimated to occur in 2003. Excavation of reservoir sediments would begin the following year. Excavation would take 6 years (2004 - 2009).

- 1) A levee would be constructed during the first year of excavation (2004). Cost of levee construction is \$4,000,000
- 2) The levee would be removed and reconstructed the fourth year of sediment excavation. Cost of levee reconstruction is \$4,000,000.
- 3) Excavation of sediments of the 6,600,000 cubic yards of reservoir sediment would occur over six years. Costs include construction of a system of trenches and pumps to dewater sediments prior to excavation. The system would be designed to handle 1,000 gallons per minute of water.
- 4) Hauling costs are based on an average distance of 10 miles to a disposal site. Sediments are hauled the same years as excavation occurs.
- 5) Disposal costs are the costs of constructing a disposal facility. Disposal occurs the same year as excavation and hauling.
- 6) A water treatment facility is built during the first year of work to treat water extracted from reservoir sediments. The facility is designed to handle 1,000 gallons per minute (1.4 million gallons per day). Operation and maintenance costs are incurred for the six years of sediment excavation.
- 7) Milltown Dam is removed the year following completion of sediment excavation (2010). Cost of dam removal is \$10,000,000.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

MILLTOWN RESERVOIR
ALTERNATIVE 108

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) LEVEE CONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	10	\$2,033,000	
2) LEVEE RECONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	13	\$1,660,000	
3) EXCAVATING AND DEWATERING	1,100,000	CY	\$6.00 CY	\$6,600,000	11-16	\$15,992,000	
4) HAULING	1,100,000	CY	\$5.00 CY	\$5,500,000	11-16	\$13,327,000	
5) DISPOSAL	1,100,000	CY	\$15.00 CY	\$16,500,000	11-16	\$39,981,000	
6) WATER TREATMENT DURING EXCAVATION							
TREATMENT FACILITY (1.4 MGD)	1	LS	\$5,600,000 LS	\$5,600,000	10	\$2,847,000	
PLANT O & M	1	YR	\$677,600 YR	\$678,000	11-16	\$1,643,000	
7) REPEAT PROCESS IN YEAR 90 (3.5% INT)	1	LS	\$77,483,000 LS	\$77,483,000	90	\$3,504,000	
SUBTOTAL						\$80,987,000	
MONITORING	1	YR	\$45,000 YR	\$45,000	10-50	\$328,000	
SUBTOTAL						\$328,000	
SUBTOTAL						\$81,315,000	
CONTINGENCY @ 20%			20%			\$16,263,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$12,197,000	
							=====
TOTAL COST:ALTERNATIVE 108							\$109,780,000

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11-Jan-95

MILLTOWN RESERVOIR - ALTERNATIVE 10B

Although issuance of the Milltown Reservoir Operable Unit Record of Decision (ROD) is anticipated in 1996, excavation of reservoir sediments would not begin until remedy and restoration actions on the Clark Fork River had been completed. This is estimated to occur in 2003. Excavation of reservoir sediments would begin the following year. Excavation would take 6 years (2004 - 2009).

- 1) A levee would be constructed during the first year of excavation (2004). Cost of levee construction is \$4,000,000
- 2) The levee would be removed and reconstructed the fourth year of sediment excavation. Cost of levee reconstruction is \$4,000,000.
- 3) Excavation of sediments of the 6,600,000 cubic yards of reservoir sediment would occur over six years. Costs include construction of a system of trenches and pumps to dewater sediments prior to excavation. The system would be designed to handle 1,000 gallons per minute of water.
- 4) Hauling costs are based on an average distance of 10 miles to a disposal site. Sediments are hauled the same years as excavation occurs.
- 5) Disposal costs are the costs of constructing a disposal facility. Disposal occurs the same year as excavation and hauling.
- 6) A water treatment facility is built during the first year of work to treat water extracted from reservoir sediments. The facility is designed to handle 1,000 gallons per minute (1.4 million gallons per day). Operation and maintenance costs are incurred for the six years of sediment excavation.
- 7) Sediments are reexcavated in year 90, if redeposition of sediments behind Milltown Dam results in recontamination of groundwater. The cost basis for this item is the total cost for items 1 through 6 (\$77,483,000). This cost is discounted at 3 1/2 percent over 90 years.
- 8) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

MILLTOWN RESERVOIR
ALTERNATIVE 10C

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
1) LEVEE CONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	10	\$2,033,000	
2) LEVEE RECONSTRUCTION	1	LS	\$4,000,000 LS	\$4,000,000	12	\$1,776,000	
3) EXCAVATING AND DEWATERING	1,293,300	CY	\$6.00 CY	\$7,760,000	11-13	\$10,352,000	
4) HAULING	1,293,300	CY	\$5.00 CY	\$6,467,000	11-13	\$8,627,000	
5) DISPOSAL	1,293,300	CY	\$15.00 CY	\$19,400,000	11-13	\$25,881,000	
6) WATER TREATMENT DURING EXCAVATION							
TREATMENT FACILITY (1.4 MGD)	1	LS	\$5,600,000 LS	\$5,600,000	10	\$2,847,000	
PLANT O & M	1	YR	\$677,600 YR	\$678,000	11-13	\$904,000	
7) REPEAT PROCESS IN YEAR 50 (3.5%)	1	LS	\$52,420,000 LS	\$52,420,000	50	\$9,386,000	
8) REPEAT PROCESS IN YEAR 100 (3.5%)	1	LS	\$59,773,000 LS	\$59,773,000	100	\$1,916,000	
SUBTOTAL						\$63,722,000	
MONITORING	1	YR	\$45,000 YR	\$45,000	10-50	\$328,000	
SUBTOTAL						\$328,000	
SUBTOTAL						\$64,050,000	
CONTINGENCY @ 20%			20%			\$12,810,000	
ENGINEERING AND ADMINISTRATION @ 15%			15%			\$9,608,000	
TOTAL COST:ALTERNATIVE 10C							\$86,470,000

* YEAR ZERO IS 1994

TIME AND DATE OF PRINTOUT:

05:01 PM

11-Jan-95

MILLTOWN RESERVOIR - ALTERNATIVE 10C

Although issuance of the Milltown Reservoir Operable Unit Record of Decision (ROD) is anticipated in 1996, excavation of reservoir sediments would not begin until remedy and restoration actions on the Clark Fork River had been completed. This is estimated to occur in 2003. Excavation of reservoir sediments would begin the following year. Excavation would take 3 years (2004 - 2006).

- 1) A levee would be constructed during the first year of excavation (2004). Cost of levee construction is \$4,000,000
- 2) The levee would be removed and reconstructed the third year of sediment excavation. Cost of levee reconstruction is \$4,000,000.
- 3) Excavation of sediments of 3,880,000 cubic yards of reservoir sediment would occur over three years. Costs include construction of a system of trenches and pumps to dewater sediments prior to excavation. The system would be designed to handle 1,000 gallons per minute of water.
- 4) Hauling costs are based on an average distance of 10 miles to a disposal site. Sediments are hauled the same years as excavation occurs.
- 5) Disposal costs are the costs of constructing a disposal facility. Disposal occurs the same year as excavation and hauling.
- 6) A water treatment facility is built during the first year of work to treat water extracted from reservoir sediments. The facility is designed to handle 1,000 gallons per minute (1.4 million gallons per day). Operation and maintenance costs are incurred for the three years of sediment excavation.
- 7) Sediments are reexcavated in year 50, if redeposition of sediments behind Milltown Dam results in recontamination of groundwater. The cost basis for this item is the total cost for items 1 through 6 (\$52,420,000). This cost is discounted at 3 1/2 percent over 50 years.
- 8) Sediments are reexcavated in year 100, if redeposition of sediments behind Milltown Dam results in recontamination of groundwater. The cost basis for this item is the total cost for items 1 through 6 (\$59,773,000). This cost is discounted at 3 1/2 percent over 50 years.
- 9) State oversight and monitoring assesses recovery of the resource and the effectiveness of restoration actions. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

MILLTOWN RESERVOIR ALTERNATIVE 10D

DESCRIPTION	QUANTITY PER YR	UNIT	UNIT COST	COST/YR 1994 DOLLARS	COST YEARS	PRESENT WORTH @ 7%*	TOTAL COST OF ALTERNATIVE
WORK ITEM DESCRIPTION							
MONITORING	1 YR		\$45,000 YR	\$45,000	10-50	\$328,000	
TOTAL COST : ALTERNATIVE 100							\$328,000

MILLTOWN RESERVOIR - ALTERNATIVE 10D

State oversight and monitoring assesses natural recovery of the resource. This item provides for monitoring of groundwater and surface water. Components of the monitoring program include well sample collection and laboratory costs by outside consultants. Costs include items such as salaries and benefits; fringe and overhead; travel and vehicles; supplies and equipment; analytical services; and data interpretation and report writing. State oversight, based on three-months of time at \$40,000 per year, is \$10,000. This includes salary, office space, office equipment and supplies, and travel and motor vehicle costs. Total cost is \$45,000 per year.

